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THE EDUCATION BILL

IN several recent issues (NATURE, 152, 393, 427, 455, 483, 517, 545) we have dealt with the White Paper which heralded the Education Bill, beginning with a general survey, and proceeding to special aspects which in our judgment most nearly touch the real problems of education in Great Britain. We now have before us the long-awaited Education Bill, with the accompanying Explanatory Memorandum*. Let it be said at once that the Bill goes far to meet the criticism and the suggestions which we, like many others, have ventured to express.

First, however, comes an unanticipated change which happens to be of cardinal importance. At present there is no real Ministry of Education. The functions of the President of the Board of Education are vaguely defined as "the superintendence of matters relating to education in England and Wales", the result being that, however convinced the President may be that a certain step is desirable, he may have no power to act, but may only be able to offer advice and bestow his blessing. The Bill proposes a radical change. There is to be no change of name. We shall still have a Board of Education and a President (with rank of Minister), but the latter will be equipped with powers which mean that we shall have something akin to a Ministry of Education, just as surely as we have a Ministry of Works or of Labour. Any fear of over-centralization of power is allayed by the importance of the functions allotted to the local authorities. The addition of Central Advisory Councils for England and Wales respectively, charged with the duty of advising the Minister on "such matters of educational theory and practice as they think fit", is a signal that the Board is meant to be a great deal more than an administrative machine.

Broadly speaking, the White Paper was received with a chorus of approval, both in Parliament and in the country, at least with regard to its purely educational proposals. Perhaps the most widely expressed sense of disappointment related to the "exceeding lack of speed" implied in the Paper. The Bill meets this criticism by taking the bold step of fixing April 1, 1945, as the date for raising the school-leaving age to fifteen, the President being empowered, however, for a period limited to two years, to retain the age of fourteen where it is impossible to provide the necessary buildings and teachers in time. The same date is fixed for the coming into operation of provisions regarding health and physical training, the modification of the dual system, religious education, and the adjustment of the present system of local administration. The date for raising the leaving age to sixteen is to be fixed by Order in Council, as soon as the Minister deems it practicable. So also will the date on which it will become the duty of local authorities to secure the provision of the necessary facilities for the compulsory part-time education of young persons.

Another of the rather bitter cries evoked by the

* A Bill to Reform the Law relating to Education in England and Wales. Pp. xii+98. 1s. 6d. net. Education Bill : Explanatory Memorandum by the President of the Board of Education. (Cmd. 6492.) Pp. 14. 3d. net. (London : H.M. Stationery Office, 1943.)

White Paper is met by a financial allocation for technical and adult education more than three times as large as that proposed in the Paper.

The duty of local authorities to secure adequate provision of primary and secondary schools, and not merely, as at present, to keep efficient the elementary schools in their areas, is to include the duty of providing nursery schools. The provision of these schools was left as a power only by the Act of 1918, and, as the event has shown, the power has been little used, notwithstanding the acknowledged necessity for these schools from the point of view of social amelioration. In this respect, as in many others, the assent of Parliament will amount to an intimation to local authorities that the nation has made up its mind on the subject.

The other failure to carry out the intention of the Act of 1918 was that which related to the ill-fated day continuation schools, opposed by the less far-seeing kind of employer, and scarcely welcomed by boys and girls, who had no desire to be sent to school again. The Bill provides for part-time continued education, not in day continuation schools, but in young people's colleges. The change of name, though perhaps sounding slightly pretentious, is exactly in the right direction, because it implies for the young person an entirely fresh start, an increased freedom from the restraints necessary during childhood, and a new opportunity of practising self-mastery. Attendance is to be obligatory for all young persons up to the age of eighteen who are not receiving full-time education. The arrangement of times is left to the local authority, but otherwise part-time education will be similarly organized throughout England and Wales.

An outstanding feature of the Bill, representing a considerable advance upon the White Paper, is that the way is opened for better provision for physically or mentally handicapped children. Hitherto the duty of ascertainment by the local authority has been restricted to defective and epileptic children. It is now extended to all types of children needing special educational treatment, including those who have come to be known as maladjusted. Also, the requirement that a handicapped child must be certified as defective before he can receive special treatment is removed. It will be the duty of the local authorities to provide special schools for the seriously handicapped, and special treatment for the less serious cases. From our point of view there are in this subject two points of compelling interest: first, that compassion towards those who are not to be winners in life's race is one of the fine things in a democracy, and, secondly, that the remedial treatment now possible is the result of applying scientific methods. In that connexion we may mention also the more general power which the Bill confers on a local education authority to "make such provision for conducting or assisting the conduct of research as appears to the authority to be desirable for the purpose of improving the educational facilities provided for their area". In this forward step one sees the promise of the substitution of scientific method for empiricism and guesswork. A similar blend of humanity and efficiency is seen in the powers conferred upon local authorities with regard to medical inspection and treatment, the provision of milk and meals, of boots and clothing—the parent to pay according to his means or lack thereof.

One result of current discussions about public schools has been to bring to the front the general question of boarding-schools for children of the unprivileged, when that arrangement seems desirable. In response to the arguments brought forward, the Bill provides that a local authority may set up a boarding school "for pupils whose education renders their residence away from home desirable, either because their parents desire that they should be educated as boarders or by reason of the remoteness of their homes or of other circumstances". Here it may be mentioned that the Bill maintains a stony silence as to the public schools, notwithstanding the lively discussions which have occurred lately, and the numerous letters that have appeared in the correspondence columns of *The Times* and of other newspapers. It is scarcely to be expected that the same silence will be maintained during the passage of the Bill through Parliament.

As to the coming Parliamentary debate, it is devoutly to be hoped that those prophets are wrong who foresee that most of it will be taken up by lengthy and perhaps acrimonious tirades about the dual system of control and the cognate question of religious education. Let anyone examine the records of the debates on the Bill of 1870, and let him cross out the parts relating to the denominational disputes, and he will find that there is not much left. We do not want, and we are sure that the general public does not want, a repetition of that vain war of words. Apart from 'the secular solution', of which we used to hear so much, but for which the general public is not prepared, there is only one way—the way of compromise, of give and take, which is essential in a democracy, and in which the British are said to excel. We trust that almost the last word has been said by way of patient and sincere and honestly sought compromise on these questions, it being known beforehand that as no one can get the whole of what he wants, so everyone will get some of what he wants. Thus the energies of Parliament would be available for educational matters which come nearer to the business and bosoms alike of parents and teachers and administrators.

One of those matters we account of vital importance is the development of a real democracy, in which every young citizen gets the opportunity to which he is entitled by his abilities. The White Paper proposed a division of secondary education into three types, to which there should correspond grammar schools, technical schools, and modern schools. The many virtues of the existing secondary schools, which inherited the traditions of the old grammar schools, were fully recognized, as also their gradual failure to meet the needs of able children who ought never to have been attracted into a type of school predominantly academic in its outlook. For them it was proposed that the secondary technical school should be developed, taking its start from the existing

junior technical schools and technical colleges. By many critics these proposals have been denounced, the grammar school as lopsidedly bookish, and the technical school as unlikely to engender that interest in the humanities which is one of the hall-marks of the well-educated man, and without which science cannot adequately express itself.

But the chief anxiety of some of the most experienced critics has been about the proposed modern schools, which must be *the schools of the masses*. It is perfectly true that the intention is to bring these schools up to the standard of the grammar schools in point of buildings, equipment, staff, size of classes, 'amenities', and so on. But just as the existing secondary schools inherited the traditions of the old grammar schools, so these senior or modern schools will inherit the traditions of the old elementary schools, into the details of which we need not enter. The staunch adherents of the democratic ideal must now, and for years to come, insist upon the fair promises embodied in the Bill being faithfully carried out, and they may have a hard struggle. The Bill does not lay down a three-fold division of the new secondary system, but leaves the local authorities to propose their plans of development. In other words, the Bill leaves room for experiment, even in the direction of the multilateral organization of American high schools. It is to be hoped that this ordered freedom to experiment will be benevolently regarded by the Minister, and will lead to valuable results. The general ends in view would be furthered if it could be arranged that a teacher's remuneration should depend upon his qualifications and experience, and not upon the kind of school in which he teaches. It would be a happy day for British education if some of the ablest and most enterprising members of the teaching profession could feel quite free to teach in any kind of school, without forfeiting one jot or tittle of their professional rights and privileges.

SCIENTIFIC PERSONNEL IN INDUSTRY

NO one who has followed the recent discussions and reports on industrial and scientific research can have failed to notice the emphasis which has been placed on the research worker himself, and on the importance of ensuring that the conditions of service are such as to attract men of the highest ability and to retain their keenness and loyalty.

There is no more welcome passage in the report* of the Industrial Research Committee of the Federation of British Industries on "Industry and Research" than that which deals with the scientific worker in industry. It is clearly recognized that on the proper position of the research worker within the organization employing him depends to some extent the power of industry to attract the best scientific brains to its service. Nevertheless, the report finds it necessary to point out that the best results can only be obtained when the research staff is taken fully into the confidence of the management and given a definite standing in the hierarchy of the organization. The research worker cannot be expected to perform his duties efficiently unless he has at his disposal all relevant information which is in the possession of the organization of which he is a member.

The report goes on to acknowledge that publication of the scientific aspects of his work is a legitimate ambition of every scientific worker, and that such ambitions are not as a rule inconsistent with the interests of firms engaged in competitive industry; on the contrary, such publication increases the prestige of the firm concerned. Again, research and development can generally only be efficient on the basis of co-ordinated team-work, with a team properly balanced as between the leader and his various grades of assistants. The personality of the leader is of the greatest importance; a successful leader is one who appreciates the ambitions and capabilities of the separate members of his team and has the gift of communicating to them his own enthusiasm and a full appreciation of the objects the team is seeking to achieve; above all, he must be able to make discriminating acknowledgment of the contribution of each member of the team to the common objective. Sir Lawrence Bragg also has emphasized the need for more inspired leaders in industrial research, and suggested that we should divert more of the national genius to industrial research by recruiting potential leaders of this kind into industry, where they should be coached for positions of high responsibility. In his view the Central (Scientific and Technical) Register could be used to locate and recruit such men.

It may be encouraging to find such statements in the report of the Federation of British Industries, but neither here nor in the comments on the benefit that has flowed from the transfer of research workers having the requisite personal qualifications to commercial, administrative and other branches of activity is there the note of conviction that makes them something more than platitudes. The more an organization is staffed on all its sides by persons having an appreciation of science and research, the more progressive and adaptable to changing circumstances it is likely to be. Little benefit indeed will be derived from increasing the numbers of those engaged on research if trained minds are not more fully employed in other branches of industry, and the general scientific outlook of industry must be raised if the understanding and application of scientific inventions, discoveries and developments by industrial firms are to be increased.

We miss in the report the urgent sense of the primary importance of seeing that scientific workers of the highest quality are first attracted to industry and then set to work under conditions which give the utmost play and stimulus to their creative powers. That consciousness clearly inspired the motion tabled in November in the House of Commons by a large number of members of all parties, asking for wider State support in planning future developments for research, teaching and higher learning as a whole, including provision for a far greater number of persons highly trained in science and technology. Again, the

* Federation of British Industries. Industry and Research: Report of the F.B.I. Industrial Research Committee. Pp. 24. (London: Federation of British Industries.)

report appears to ignore all those fundamental questions of the organization of research in relation to the personal factor which are vital and which were discussed by Dr. Alan Gregg, director for the medical sciences at the Rockefeller Foundation, in his Terry Lectures, "The Furtherance of Medical Research". Standards of remuneration must indeed be high enough to attract and to hold men of outstanding ability. They should also be such as to ensure that preoccupation with proper provision for their families does not intrude unduly on the research worker. Lord Bledisloe has rightly stressed the importance of mental concentration, quietude of mind and freedom from domestic anxieties if the research worker is to give of his best.

While, however, certain minimum standards are essential, the vital factor is the maintenance of the highest possible professional standards, the clash of mind with mind especially on the borderlands of sciences, the correction by every possible means of the ingrained evils of specialization. Refresher courses may do something to help, as may the transfer of staff within and without industry, for Lord McGowan was profoundly right in urging that scientific workers should not allow the lavish provision of scientific literature in the industrial library serving the research department of a large firm to lead them to refrain from joining professional societies and attending scientific meetings and participating in the discussions. The warning is timely and is a reminder of one respect at least in which the maintenance of the highest standards of research is a matter for the scientific worker himself.

A more generous policy in publishing the results of industrial research, as advocated by Lord McGowan and Dr. P. Dunsheath, and by Mr. Samuel Courtauld in a recent article in *The Times*, would undoubtedly have a vitalizing effect in this respect, and its indirect consequences in stimulating discussion and professional association might be out of all proportion to the direct value of interchange of information to which Lord McGowan referred, in such matters as fuel economy, heat transfer, corrosion and the design and performance of plant. Moreover, the question of the suitability of the present patent law system of Great Britain in this respect has been raised too often for it to be dismissed quite so cursorily as it was by Lord McGowan. It was raised most explicitly by Dr. Dunsheath, and Mr. Courtauld returns to the point when he urges that it is open to question whether the Government should assist research by direct contribution, or by remitting taxation, while allowing the fruits of that research to be withheld from the nation by means of patents not fully and efficiently worked.

On the other hand, as Mr. Courtauld recognizes, publication has its own difficulties. Government-maintained institutions must have a free hand, and fundamental research will be one of their main functions. The publication of fundamental discoveries must be subjected to the decision of a very high and impartial tribunal, always with an eye on possible foreign competitors. Existing interests must not be allowed to retard publication beyond the point where these coincide with public policy.

Mr. Courtauld is here entering on the difficult question of social adjustment. It may indeed be right and for the advantage of the community that a particular industry should be closed down, because of other benefits arising from the discovery or invention responsible. It may be questioned, however, whether this is relevant to the question of publication: if we make sure that such decisions affecting the fate of an industry are not determined by private interests but by public policy, which takes account of the displacements and adjustments involved, there seems to be no intrinsic reason for barring publication. Moreover, Mr. Courtauld's remarks in this connexion appear to threaten that full and free interchange of fundamental knowledge across national frontiers which is essential to scientific advance and the defence of which is one main concern of men of science in the present War.

Mr. Courtauld's challenge to the old-fashioned love of secrecy is, however, unmistakable, and many will hold with him that it has brought more harm than good to the manufacturer. Undoubtedly it undermines the relations between the research staff and management and hinders the establishment of that full confidence and understanding which play so important a part in stimulating research and bringing its conduct to the highest efficiency. The more liberal policy pursued in the United States may well be an important factor in some of the industrial achievements in that country. Mr. Courtauld is unquestionably right in holding that the maximum degree of publication and co-operation consistent with reasonable safeguards against abuse will accelerate the healthy growth of every industry based upon applied science.

It is clear, therefore, that the reports to which we have referred are far from exhausting this question of establishing the conditions under which research can be carried on with the greatest advantage. Fundamentally, we still know relatively little of the biology of invention or discovery, but in the organization and maintenance of research we are often very far from applying all the knowledge at our disposal, and these reports afford welcome evidence that this is realized and that further attempts are being made in this direction. Moreover, they indicate that industry is coming to understand that more could be done even before the scientific man enters the service of industry; the greater interest being taken by industry in technical education, and the recommendations for the more general provision of funds for the creation of fellowships, bursaries or the like at universities and technical schools and colleges for junior personnel in the industry who show an aptitude for a scientific career, are encouraging signs.

How great is the need in this respect is shown in an interim report of the British Association Committee on Post-war University Education dealing with university entrance scholarships in England and Wales*. It is not merely that the supply of scholar-

* British Association. Committee on Post-War University Education. Report on University Entrance Scholarships in England and Wales. Pp. 8. (London: Burlington House, 1943.) 6d.

ships is inadequate, and that in particular if adult education becomes much more widespread there should be an increase in the number of university entrance scholarships offered without an upper age limit; the methods of selection themselves receive severe criticism. The Committee holds that the present system harms a large majority of the scholarship candidates, subjecting them to conditions which place a premium on absorptive processes; it ruins altogether a small percentage of the candidates and misses some first-rate material.

The attention which industry is already giving to qualities other than purely intellectual attainments in selecting its recruits should lead it to mark very carefully what this report says about the deleterious effect of the present scholarship system upon the social life of the school, and particularly the untoward effects, on boys much more worth while than many of the successful candidates, of concentrating undue attention upon the more brilliant minority. The Committee gives a strong warning as to the necessity of carrying selection a step further. If we are to make the best of our youth, we need to get into our universities more of the leaders of the coming generation as well as the intellectual elite. We need, besides scholars of outstanding intellectual quality, men and women who combine good intelligence with qualities of character and personality, so as to be the natural leaders in other fields than those of science and learning.

This plea for character and leadership is one to which assuredly industry should not turn a deaf ear. The plea that the assessment of deep scholarship should always be accompanied by the assessment of character, and that the latter for most assisted students should carry equal weight in considering their worthiness to be admitted to a university, has strong claims on the support of industry, which is already beginning to assess its recruits by some such standards. Industry could indeed, if it chose, lend powerful support in overcoming the obstacles to the appropriate remodelling of the scholarship examinations involved in the success of any such reform, and the experience of the interview it already possesses might well be drawn upon in establishing the more effective use of the interview, with the appropriate safeguards, in examinations for entrance scholarships to universities. With that, and with real weight attached to the candidate's school record, to his English essay and to his general papers as well as to his intellectual promise in his own special branch of study, we may well find such an improvement in the quality of the recruits industry draws from the universities as will react profoundly not only on the quality of industrial research and on the application of advances in science, but also on the whole standard of industrial leadership and management. What is essential is that industry should show even more of the spirit of co-operation and open-mindedness which these reports and papers display, and tackle with more determination and thoroughness those fundamental questions of the organization and the management of research over which the Federation of British Industries tends to pass too lightly.

HISTORY OF ELEPHANTS

Proboscidea

A Monograph on the Discovery, Evolution, Migration and Extinction of the Mastodonts and Elephants of the World. By Prof. Henry Fairfield Osborn. Edited by Mabel Rice Percy. (Published on the J. Pierpont Morgan Fund by the Trustees of the American Museum of Natural History.) Vol. 2: Stegodontoidea, Elephantoidea. Pp. xxvii+805–1176+19 plates. (New York: American Museum Press, 1942.) 20 dollars.

THE Proboscidea are such very large animals that their fossil bones and teeth attracted attention in the far distant past, but only in 1698 did W. E. Tentzelius prove that giant bones found in a sandpit at Tonna in Thuringia were those of an elephant, and were not "minerale fossile, sed animale petrifactum". Before 1800 Blumenbach and Cuvier showed that some fossil elephant teeth belonged to species and genera no longer living.

Hugh Falconer, who died with much of his work unpublished in 1866, brilliantly ended another phase of the discovery and interpretation of fossil elephants by showing that they could be arranged in a morphological series providing every intermediate stage of tooth structure between a primitive mastodon and the most advanced true elephant, the mammoth. With the general acceptance of the theory of organic evolution, it was at once realized that Falconer's morphological series was in a wide sense an evolutionary one, but little real advance was made until, in 1904, C. W. Andrews found in Egypt two evolutionary stages earlier than any then known, which fitted into place before the beginning of Falconer's series; and went on to give a convincing explanation of "how the elephant got his trunk".

Dr. Andrews was well aware that the series of forms he used was not a real phytogenetic series, that Moeritherium, its earliest term, was not actually the ancestor of its successor Palæomastodon, and similarly for the other stages. But he realized, for example, that *Trilophodon angustidens* was representative of all other Lower Miocene mastodons in its characteristic greatly elongated lower jaw, and that no form with the shortened, but still long, lower jaw of his next stage, *Tetralophodon longirostris*, had been found in rocks older than the Upper Miocene.

In his mind, the important fact was the time of first appearance of each stage of evolutionary advance, the trend of evolution being established on that basis without any attempt (which would then have been impossible) to sort out independent genetic lines among the whole material of fossil Proboscidea (cf. *Phil. Trans.*, B, 196, 101).

In 1907, H. F. Osborn began to bring together in the American Museum of Natural History materials which would enable him to apply to Proboscidea those methods of analysis of structural details which he had already conceived and used in the study of Rhinoceroses and Titanotheres. In 1920, he began that detailed work, which continued until his death in 1935. At that time, 1,240 figures, each often containing many individual drawings or photographs, had been prepared for publication, much of the text was complete and some of it in type, and an immense accumulation of notes existed. The piety of Miss Mabel Rice Percy and others has enabled the whole to be published in two magnificent volumes, of which the first was reviewed in NATURE (138, 860) on its

publication in 1936, while the second, devoted to the elephants and their immediate predecessors, appeared in 1942.

The circumstances of its publication have made this monograph exceedingly difficult to read and understand, for early interpretations crop out among later views, especially with respect to the age of Asiatic forms, and there is much repetition. The present volume, however, contains an invaluable and most judicious chapter by Dr. E. H. Colbert on the "Geologic Succession of the Proboscidea", which should be read as an introduction by anyone studying the whole; and a modern interpretation in footnotes corrects earlier statements of the age of each species.

None the less it is a difficult work, only to be understood by persons who have a familiarity with actual fossils and the earlier works which have been written about them. But it is invaluable, one of the greatest of all palæontological works, because it brings together an immense material, illustrates it fully by most accurate and intelligible figures, and applies to it a minute analysis of structures and a mode of interpretation which is comprehensible and logical.

According to Osborn, the actual history of the elephants is as follows. In lower and middle Miocene times there existed mastodons which can be distinguished from all others because the transverse crests on their first and second molar teeth, three in number, are separated by valleys which are not blocked by subsidiary cusps. They have long lower jaws, in common with all other mastodons of the same times. This group can be divided into three; one, distinguished by the fact that each crest on the molars is cleft into two halves, leads on to the 'American' mastodon. The second group lacks the cleft which splits the molar crests, but each crest bears four or five subsidiary cusps on its summit. The upper tusks lack an enamel belt. The third group, Turicius, is distinguished from the second by the presence of a ridge descending into the valley on the posterior surface of one end of each molar crest, and of an enamel band on the upper tusks. Each of these three groups can be followed to Middle Pliocene or later times, the lower jaw shortening and the crests becoming higher, though not more numerous, in accordance with the evolutionary trends established by Falconer and Andrews.

The third group, Turicius, is held by Osborn to include in all probability the ancestors of the true elephants. Before it had died out there appears a new genus, Stegolophodon, the oldest member of which, from the base of the Pliocene, differs from Turicius in having four crests instead of three on its first and second molars, which have very low and swollen crests with some six conelets on their summits, but retains the enamel band on the upper tusk. This genus lives on to Lower Pleistocene times.

In Middle Pliocene times appeared the genus Stegodon, with six or seven crests on its first and second molars, each bearing some nine subsidiary cusps on its summit, and having the valleys partially filled by cement. Stegodon lived on to Middle or Upper Pleistocene times, the series following the normal evolutionary course, so that the second molar of the last form has nine very high crests and the third fifteen crests.

But in Lower Pleistocene times appears the first true elephant, *Archidiskodon planifrons*, with nine or ten crests on its second and twelve on its third molars, each crest having six to ten conelets on its summit. The real difference between this animal and a Stegodon with a similar number of crests is in the fact that in it the crests have become plates with parallel sides, while in Stegodon they are wedge-shaped in section. But the very primitive South African *A. proplanifrons* and the very advanced Japanese *Stegodon auroræ* bridge the gap.

From *Archidiskodon planifrons* arose a series of elephants, with skulls of comparable shapes, in which the numbers of plates in the teeth increase to eighteen in the third upper and twenty in the third lower molars. The teeth become immensely deep, a plate measuring so much as 24 cm., compared with a maximum of 6 cm. in *A. proplanifrons*.

The final term of this series, *A. imperator*, with its varieties, reached the height of thirteen feet, and its tusks, much curved and with their inwardly directed tips crossing, may reach the astonishing length of sixteen feet. This line survived to Upper Pleistocene times. Parallel to it, and also found both in Europe and North America, are two other lines of descent, one leading to the Arctic mammoth, the other including the European *Parelephas trogontherii* and many American species.

The three groups differ markedly in the shape of their skulls, but it is often difficult to distinguish isolated teeth with certainty. The Parelephas line ranges from Lower to Upper Pleistocene, the plates of the last molar increasing in number from fourteen to thirty and the heights from 15 cm. to 24 cm. The mammoth line can also be followed from Lower to Upper Pleistocene times, the ridges increasing from nineteen to twenty-seven, while the height changes little. It can be distinguished by its high, short, pointed skull, in contrast to the rounded cranium of Parelephas.

Osborn having in this way worked out three lines of descent (the lineages of invertebrate palæontologists), which he calls sub-families, among the very close allies of the mammoths, proceeds to deal similarly with other elephants.

One family includes those elephants in which the bases of the tusks diverge widely. It also is divided into three sub-families; one of which, badly known, ends in the living African elephant, another includes a giant Indian Pleistocene form and the pigmies of the Mediterranean Islands, while the third is erected to contain the straight-tusked elephants of the European Pleistocene. Each sub-family shows some part of an evolutionary story of tooth development paralleling that of the mammoths.

Finally, a third family includes the living Indian elephants, the ancestry of which is unknown, and two allied forms from the Middle Pleistocene of the Sivaliks.

Prof. Osborn has thus made the first attempt to work out in detail the phylogeny of the 330 extinct species of Proboscidea which he regards as well founded. He has done so by the systematic search for criteria for the discrimination of closely similar animals which are members of stocks pursuing parallel evolutionary courses, and finally recognized twenty-one independent lines of this kind which may be followed for longer or shorter periods.

The most important conclusions which follow from Prof. Osborn's work seem to be as follow:

(*a*) The evolution of the Proboscidea is polyphyletic, stocks which separate from one another at any time afterwards pursuing parallel evolutionary courses.

(*b*) Comparatively inconspicuous features of the

teeth may persist unaltered, or little changed, for long periods.

(*c*) The evolution of such characters as the number of crests on a molar tooth is independent of the evolution of other characters of the tooth, such as the height of the crest.

(*d*) New progressive stocks arise from a point only a little above the base of the parent stock.

(*e*) Two stocks which separate from one another may differ very greatly indeed in the rate at which evolutionary changes take place in them.

(*f*) Progressive stock and parent stock may continue to live side by side, so that their remains may be buried in the same bed.

(*g*) The evolution of the Proboscidea has been a rapid process in comparison with that of horses or camels.

(*h*) The extinction of sub-families of Proboscidea occurred at all geological periods, twelve sub-families living on into Pleistocene times, four—two mastodons in America and two elephants—surviving to Recent time, two only still living.

The history of the elephants has thus been more completely illustrated than that of any other mammalian order, because in other cases no man has had at his command resources which enabled him to bring together in one place so much material, to have this material prepared and illustrated, to allot special points to able collaborators for further investigation, to have published papers sought for, translated and abstracted, and the notes of many years work kept in order by a most able secretary. If these conditions could be met, it is probable that many other mammalian orders and sub-orders would yield the details of an even more complete story, now existing fragmentarily in scattered publications.

It is perhaps useful, because of its great importance to archæologists, to direct attention to the fact that a South American mastodon, *Cuvieronius postremus*, has been found in Ecuador in association with human artefacts which are only 1,600–1,800 years old.

D. M. S. WATSON.

THE TRAINING OF A REGIONAL PLANNER

Regional Planning

An Outline of the Scientific Data relating to Planning in Great Britain. By L. B. Escritt. Pp. 264. (London: George Allen and Unwin, Ltd., 1943.) 12*s*. 6*d*. net.

THE author of this handbook considers that regional planning is "a real study of growing importance", and that in the training of those who will undertake such planning more studies are involved than engineering and architecture. He shows the relevance of geology, the study of soils and soil surveys, of agriculture and land utilization, and a wide range of other subjects. In the space of little more than 250 pages, he has endeavoured to demonstrate the ways in which a knowledge of these subjects can be applied to problems of regional planning. He has written, generally, for the uninitiated, and has not assumed much preliminary training in any of these subjects.

The book "is addressed in particular to town planning, engineering and architectural students", but it is hoped that it will also be of interest to local government administrative officers. It may perhaps be hoped that no students of regional planning will confine their knowledge, for example, of geology, to the brief summary given in this volume: the useful lists of references to general literature and to publications specially dealing with planning will be a stimulus to much wider reading. But apart from the student aiming at professional qualifications, it may be suggested that many non-technical members of planning committees, reconstruction associations and similar bodies will find much in this volume to interest them.

An introductory chapter is followed by an attractive account of regional surveying, a subject in which Mr. Escritt evidently takes a keen interest. He makes frequent reference to the "Atlas of Croydon" and to the regional survey on which it was based: several illustrations reproduced here have been derived from that source. He strongly urges the need of such surveys as a basis for post-war planning.

In the fourth chapter Mr. Escritt discusses the education of the planner. He points out that the Scott Report expressed some dissatisfaction with the training of planners, and put forward the view that many employed as town planners are inadequately trained in the broader aspects of their work.

Mr. Escritt makes interesting comments on the syllabus prepared for the Town Planning Institute examination, and notes that at present "all universities that provide courses of study in town planning treat planning as a section of architecture, or include it as part of the work of an architectural department". He puts forward tentatively a scheme of study for those who enter the profession of planner via the universities. He suggests that this course should include work in geology, agriculture (including soil survey and forestry), economics, engineering (with some mathematics, physics, surveying, municipal engineering), architecture, regional surveying and planning. Obviously, a course designed to cover such a wide range of studies would need to be of longer duration than most degree courses, while the provision of a unified scheme of instruction in such a field would present problems of great difficulty. It may be wondered whether the training of regional planners would not be more satisfactorily approached by way of certain existing degree courses, with subsequent postgraduate instruction in those subjects which are not represented in the curriculum for the degree. Certain people would thus approach the problem with a training in engineering or architecture, others with a more general background of science or geography. For some types of regional planning it is likely that an honours course in geography, including surveying and some geology, would provide a better training in the broader aspects of the problem. Indeed, many will think that it is preferable for undergraduates to follow such courses before embarking on vocational training. If we are to have a body of professional planners, it may be most desirable to give only sufficient technical training to enable them to know which experts should be consulted.

In subsequent sections the author deals with "The Earth and its Products" (geology, soil, agriculture), "The Water Cycle" (drainage, water supply, sewerage), "The Town", and "Transport". Much ground has been covered, and Mr. Escritt has taken advice from a long list of specialists in order to make his work authoritative. As a small detail, a question may be asked regarding the use of the word 'hachure' on pages 48 and 50, which is not in accordance with the familiar practice in Great Britain.

A. E. TRUEMAN.

Formalization of Logic

By Prof. Rudolf Carnap. (Studies in Semantics, Vol. 2.) Pp. xviii+159. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1943.) 16*s*. 6*d*. net.

THE starting-point of Prof. Carnap's work is the distinction between two aspects or tendencies in logic. On one hand, there is the tendency to emphasize form, the logical structure of sentences and deductions, relations between signs in abstraction from their meaning: this is Hilbert and Bernays' *Beweistheorie*, Carnap's *syntax*. In contradistinction to it is the emphasis on meaning, interpretation, relations of entailment and compatibility as based on meaning, the distinction between necessary and contingent truth, etc.: this is *semantics*, and corresponds generally to Hilbert and Bernays' *mengentheoretische Logik*. Prof. Carnap is planning a series of studies on semantics, of which the volume under review is the second (the first being an "Introduction to Semantics"); it deals with the application of his methods to a criticism of the formalization of logic, that is, its representation by a formal system or calculus. The problem is to determine to what extent the logical calculi that have been constructed hitherto have actually effected the task of formalizing logic in such a way that the principal logical signs can be interpreted only in terms of the accepted logic of meaning; a question which the author answers in the negative. He shows, however, that a full formalization of propositional logic, and also of the logic of functions, can be effected by making use of new basic concepts, the most important step being the introduction of *junctives*, that is, of sentential classes in conjunctive and in disjunctive conception.

The book is an important contribution to the development of its subject.

Mathematical Statistics

By S. S. Wilks. Pp. xi+284. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1943.) 25*s*. net.

IN the preface Dr. Wilks makes the remark, "If and when the present notes are revised and issued in a permanent form", which suggests that the author does not need reminding of the disadvantages of giving his work to the world in a paper-covered volume of litho-printed typescript. The reviewer has certainly found this format uncomfortable.

As to substance, it is clear that Dr. Wilks has industriously gathered much material from the periodical literature, rewritten it in a consistent, if austere, mathematical notation, and thrown overboard as superfluous almost all discussion of relevance and applicability. Whatever value the course of lectures on which it is based may have to the mathematical students who take them, it seems to give no insight into *why* any particular problem should be propounded, or as to the function of mathematical reasoning in improving statistical methods. Time after time a perfectly competent, though perhaps arid, section closes with a note of finality, without a hint of the wider horizons which might have been disclosed.

The book as it stands may well be useful to some, who occasionally need to refer to a careful and precise statement on some special point. They will not find it elaborated, or exemplified; and may well be disappointed, on the purely mathematical side, by the author's pedestrian style, for the development of mathematical statistics has not really been poor in those flashes of originality and penetration which mathematicians sometimes call 'artifices'. Dr. Wilks should not disdain to reproduce such work, for, like all good artistry, it gives much pleasure, without detriment to practical aims. R. A. F.

Oddities of Natural History

By Eric Parker. Pp. 228+8 plates. (London: Seeley, Service and Co., Ltd., 1943.) 12*s*. 6*d*. net.

READERS of the *Field* will be familiar with the kind of letters that find their way into the correspondence column of that journal. This column serves as a sorting-house for the unusual incidents and observations which are little known in the animal kingdom and for which we are deeply indebted to so many 'amateur' naturalists. In order that the more significant of these observations should be available in readily accessible form, Mr. Eric Parker has made an exhaustive examination into past issues of the *Field* over many years, and his collected findings are set out in this book. It will be of most value to those actual or would-be correspondents to the *Field* whose propensities enable them to interpret the behaviour of animals in terms of human sentiment and emotions. They will read the book with avidity. Naturalists who find the anthropomorphic and teleological assumptions a deflexion from rational objectivity will find much to irritate them. Parker's approach is in direct contrast to that of the writer whose recent book on the life of the robin showed how it is possible to maintain the strictest regard for exact observation and interpretation without in any way concealing one's love for the subject being studied. T. H. H.

A Star Atlas and Reference Handbook (Epoch 1950)

For Students and Amateurs. By Arthur P. Norton; the Reference Handbook by J. Gall Inglis and A. P. Norton. Ninth Edition. Pp. xvi+90. (London and Edinburgh: Gall and Inglis, 1943.) 15*s*. net.

THE first edition of this work appeared in 1910, and this latest edition—the ninth—contains a number of alterations to bring it more up to date. Stars from the Revised Harvard Photometry down to magnitude 6·35 have been charted, and all nebulæ, except those of Messier and those classed by Herschel, have received the N.G.C. numbers. Small circles are used to indicate all variable stars which attain the sixth or seventh magnitude at their maximum brightness. The recommendation of the International Astronomical Union regarding the galactic equator and poles has been adopted, so that these differ a little from those shown in the maps of the earlier editions. In the earlier maps, limited abbreviation lists were printed in the margins, and these have been replaced by a complete list occupying a page, preceding the charts.

In addition to the value of the work as a star atlas, it contains most useful and authoritative information on star nomenclature; astronomical terms; the galaxy and the stars; spectroscopy; the sun, moon, and planets; the care and use of the telescope. It is remarkable that so much reliable detail has been condensed into a little more than fifty pages, and the provision of an index at the beginning of the book enables one to turn immediately to the page which supplies the necessary information. An astronomer's library is incomplete without a copy of this valuable work.

DICHROISM

By Dr. W. D. WRIGHT

Imperial College of Science and Technology, London

"Will all great Neptune's ocean wash this blood
Clean from my hand? No, this my hand will rather
The multitudinous seas incarnadine,
Making the green one red."—*Macbeth*.

IN the tough and stirring days in which he lived, Shakespeare can scarcely have failed to notice that a dilute solution of blood is yellow in hue instead of red, but at least he had no opportunity to learn that the same change of hue is also apparent when blood corpuscles are examined under a microscope. This observation, which has been the subject of recent correspondence in NATURE[1,2,3], appears at first sight to be one of those odd effects which can only be explained by reference to some peculiarity of vision. Actually it is an interesting and important example of the general phenomenon of dichroism, an all-embracing term used to describe the changes in hue which some media and surfaces undergo in certain conditions. Thus dichroism includes changes in hue which are observed with some media, such as blood, when their thickness or concentration is varied, the very striking and dramatic changes in colour of certain dyed materials when viewed successively in daylight and in artificial light, and the undertone of a pigment which is observed to differ in hue from that of the mass of the pigment when the latter is greatly extended with white. While it is true, as will be seen later, that certain visual factors are involved, yet the phenomenon has an essentially physical origin which is revealed when calculations are made to determine the spectral composition of the light reaching the eye.

The coloration of a medium is due to the freer transmission of some parts of the visible spectrum than others; thus a pigment which transmits mainly in the long-wave end of the spectrum will be red, one which transmits both the red and blue radiations will be purple, and so on. If, then, we wish to discover how the colour of a medium changes on reduction in thickness or on dilution, we have first to derive the spectral transmission curve for each thickness or concentration. As an example, consider a hypothetical medium in which the transmission factor T_0 for unit thickness and unit concentration of the medium is given for each wave-length in the visible spectrum by curve *A* in Fig. 1. In this case we have maximum transmission in the green at a wave-length of 0·52 μ with a rapid and roughly symmetrical decrease on each side of the maximum, and we can conclude that the sample will possess a deep green colour. Further, we can use curve *A* to calculate the transmission curve for other thicknesses (or concentrations) by applying Beer's and Lambert's laws. These laws can for the present purpose be conveniently expressed by the equation

$$T = T_0^{cl},$$

where T is the transmission factor for wave-length λ for a concentration c and thickness l, while T_0, as stated above, is the transmission factor for the same wave-length but for unit concentration and unit thickness. (This relation is satisfactory, provided the reflexion losses at the surfaces of the medium are neglected.) Applying this equation for the cases when $c = 1$ and $l = \frac{1}{2}$, $\frac{1}{10}$ and $\frac{1}{20}$, we obtain three new transmission curves *B*, *C* and *D* respectively (Fig. 1).

Reduction in thickness is seen to increase the transmission at all wave-lengths, but it will also be noticed that the increase is relatively very much greater at those wave-lengths which are most absorbed. The extent to which the green wave-lengths are in excess of the other radiations thus steadily diminishes with reduction in thickness so that, with the thinnest specimen, curve *D*, the transmission curve shows only a slight decline on either side of 0·52 μ. It is then easy to understand why, when each specimen is illuminated in turn by a beam of white light, the deep green coloration becomes progressively paler or more desaturated until, in the case of curve *D*, it is reduced to a white with merely a tinge of green.

Since no obvious change of hue will accompany the desaturation, the effect would not appear in any way abnormal and would give no occasion for comment. This, however, is due to the hypothetical absorption curve assumed in Fig. 1, a curve which is more regular and more symmetrical than that found for most absorbing media. It is not difficult to see that if there had been a subsidiary maximum of transmission at some wave-length other than 0·52 μ, say in the red, then the relative transmissions of red to green would have changed with different thicknesses of the medium and the hue of the specimen would have moved from green towards the yellow as the red component in the transmitted light became increasingly effective. Or again, if there had been some heavy absorption at a particular part of the spectrum, then when a very thin layer was examined, all wave-lengths except those in or near the absorption band would be

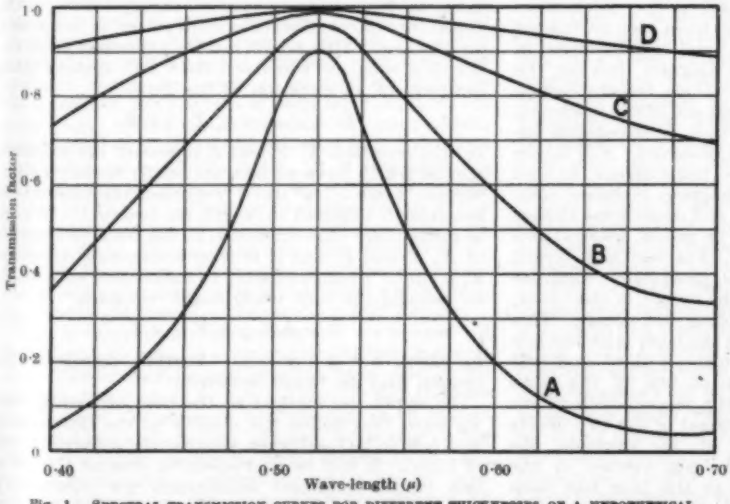


Fig. 1. SPECTRAL TRANSMISSION CURVES FOR DIFFERENT THICKNESSES OF A HYPOTHETICAL GREEN MEDIUM.

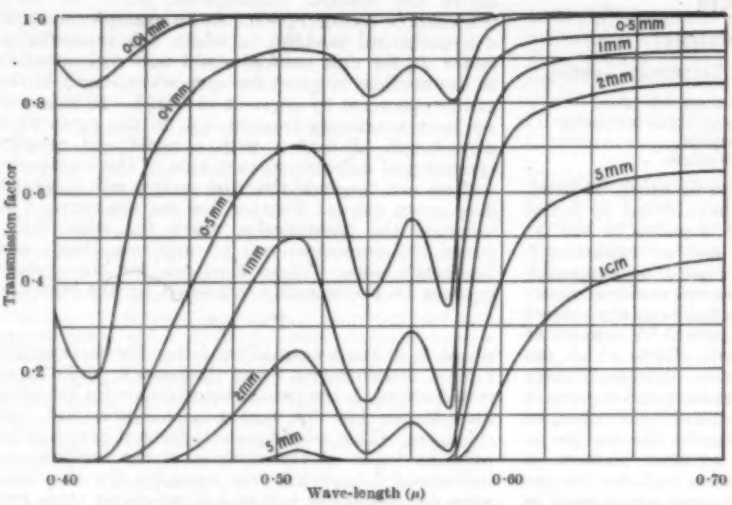


Fig. 2. SPECTRAL TRANSMISSION CURVES FOR DIFFERENT THICKNESSES OF OXYHÆMOGLOBIN (1 PER CENT CONCENTRATION). THE THICKNESSES OF EACH LAYER ARE SHOWN AGAINST THE CURVES.

transmitted with little loss in intensity, yet within the absorption band the reduction might still be appreciable. In that event, the specimen would acquire a hue complementary to that of the absorbed wave-lengths.

As it happens, the transmission curve of hæmoglobin shows that both characteristics—a strong absorption band and a subsidiary transmission maximum—are present to cause the change in hue from red to yellow which is observed with decreasing thickness and concentration. Thus, from the colorimetric point of view, the most important features of the transmission curve of blood are the high transmission at the long-wave end of the spectrum, the secondary peak in the transmission at a wave-length of 0·51 μ and the very strong absorption band in the violet at 0·42 μ.

The complete transmission curves of oxyhæmoglobin (1 per cent concentration) for thicknesses ranging from 1 cm. to 0·01 mm. have been calculated from data given by Heilmeyer[4] and are illustrated in Fig. 2. It is seen from this diagram that for the thickest layers, the only radiations transmitted in any strength are those at the red end of the spectrum, and it is this transmission which is responsible for the deep red colour normally observed. For layers of intermediate thickness the transmission around 0·51 μ in the green and blue-green becomes comparable to that in the red and will cause some change in the hue towards the orange or yellow, assisted also by the transmission at 0·56 μ. For very thin layers, on the other hand, there is practically complete transmission of all wave-lengths except in the violet, where some significant absorption still occurs. This will have the effect of tingeing the layer with the hue complementary to violet, namely, yellow, and will therefore introduce a change of hue of the same character as that caused by the transmission in the green. The similarity in the trend of the two effects is, however, a coincidence; if, for example, the strong absorption band had been located in the yellow while the absorption in the blue had been less severe, the hue at intermediate thicknesses would have first moved towards the yellow, yet in very thin layers it would have shown a slightly bluish tinge.

Although the spectral transmission curve of a medium gives a complete physical picture of the changes in light transmission which occur with change in thickness, the estimation of the colour as such can at best only be approximate, since no account is taken of the manner in which the different spectral radiations combine in the eye. A more complete analysis may be achieved by expressing the colour in terms of a trichromatic equation on the C.I.E. system[5], in which the quality of the light is defined by the proportions in which three reference stimuli have to be mixed additively to produce the same colour sensation as that produced by the light under investigation.

The methods involved in colorimetric calculations of this kind are now well established and are employed extensively in technical problems, although there are many persons interested in colour to whom they are still unfamiliar. The experimental foundation for the system depends on the fact that a colour can be matched by a suitable mixture of three radiations, and further, that the quantities involved in the match obey the ordinary rules of arithmetic; that is to say, if the brightness of the test colour were halved, the amounts of the three matching radiations would also have to be halved to maintain a match, and so on.

Assuming that we know the amounts of the three reference stimuli which would be required to match unit energy of each monochromatic radiation in the visible spectrum, we can, by a process of multiplication and summation, reduce any beam of light, as defined by its spectral energy curve, to the visual equivalent of three stimuli mixed in the correct proportions. This result can be expressed by a tristimulus equation which, on the C.I.E. system, takes the form of an equation of the type

$$C = x'.X + y'.Y + z'.Z.$$

In this equation X, Y and Z represent the reference stimuli which have an internationally specified significance, while x', y' and z' represent the amounts of the stimuli required to match the colour C. We are in many cases only interested in the relative amounts of X, Y and Z, and it is then convenient to reduce x', y' and z' proportionately to make their sum unity, so yielding the unit trichromatic equation

$$C = x.X + y.Y + z.Z,$$

in which $x + y + z = 1$. Further details of the system may be found elsewhere[6,7,8].

To apply the method to the case of hæmoglobin, we must first define the quality of the illumination which is to be used when viewing the different layers of blood. It will be convenient to assume the use of one of the standard illuminants for colorimetry, namely, the C.I.E. source S_B which, with a colour temperature of 4,800° K., has a quality somewhat

similar to daylight. From the energy distribution of the light radiated by this source and from the transmission curves of oxyhæmoglobin given in Fig. 2, the spectral composition of the light transmitted through each layer can be calculated. From the colorimetric data given in the C.I.E. tables, the relative amounts of X, Y and Z required to match each layer can be calculated on the lines indicated above, and the results recorded on the chromaticity diagram.

This diagram is illustrated in Fig. 3, *a*. The values of x and y are recorded along the horizontal and vertical axes respectively, and the co-ordinates (x, y) of any point in the diagram provide a unique definition of a colour. (The third co-ordinate, z, is given by $z = 1 - x - y$.) The diagram is thus in the nature of a colour chart, but it also embodies the facts of colour mixture; for example, the result of mixing any two colours as defined by their positions on the chart is to produce a third colour located on the straight line joining the two colours being mixed. The locus of the spectrum colours in the chart is illustrated, as well as the position of the white point S_B. When a colour is represented by a point lying close to the spectrum locus, then it means that it is highly saturated with a hue similar to the monochromatic radiation to which it is a neighbour, but as it approaches S_B, so the hue becomes less pronounced and the colour becomes more desaturated.

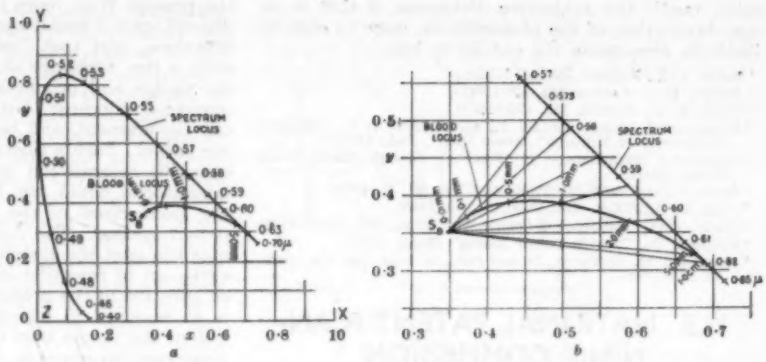


Fig. 3. (*a*) THE C.I.E. CHROMATICITY CHART SHOWING THE SPECTRUM LOCUS, THE WHITE POINT S_B AND THE BLOOD LOCUS. (*b*) AN ENLARGED SECTION OF THE CHART SHOWING THE BLOOD LOCUS AND PART OF THE SPECTRUM LOCUS. WAVE-LENGTHS ARE INDICATED AGAINST THE SPECTRUM LOCUS AND THE THICKNESS OF THE HÆMOGLOBIN LAYERS AGAINST THE BLOOD LOCUS.

We can now deduce the changes which take place in the colour of the blood layers. The points for each of the seven layers of Fig. 2 have been plotted in Fig. 3 to give the blood locus in the chromaticity diagram, a locus which starts near to the radiation 0·62 μ and terminates, for extremely thin layers, at S_B. The locus is shown enlarged in Fig. 3, *b*. If straight lines are drawn from S_B through the points representing each layer and extended to intersect the spectrum locus, the points of intersection will give the dominant wave-length of each layer, that is, the wave-length of the monochromatic radiation which, when mixed in a suitable proportion with S_B, would match the colour of the layer. It is seen that the dominant wave-length ranges from 0·62 μ, an orange red, to 0·575 μ, a yellow, and we thus arrive at the numerical evidence for the change of hue which we deduced from general considerations from Fig. 2. If there had been no change in dominant wave-length with thickness, the blood locus would have been a straight line from the region of 0·62 μ to S_B.

For a proper understanding of each case of dichroism, this type of colorimetric analysis is necessary. The case of hæmoglobin has been used as an example, but it could be applied equally well to those cases quoted, for example, by Paterson[9] or by Baker[1] and Webb[3], and to the changes occurring when coloured samples are viewed under different illuminations. Practically all absorbing media are to some extent dichroic in the sense that the colours of different layers do not lie exactly on a straight line when plotted in the chromaticity diagram, but in many cases the departure from linearity is too small to attract attention by any noticeable change in hue. On the other hand, there are many media, such as malachite green or quinoline blue, in which the change of hue is even greater than that of blood.

There remains one final consideration. The specification of a colour on the trichromatic system is a physical specification of the colour in the sense that it defines the mixture of three stimuli required to produce the same colour sensation as the test stimulus; no claim is made, or could be made, that it measures the sensation itself. While we can, from its position in the chromaticity diagram, state that a colour may be red or green or white, as the case may be, or, when comparing two colours, decide that one is yellower than the other, or more desaturated, and so on, we cannot give any precise description of the appearance of the colour under any given observing conditions, except to say that the three stimuli mixed in the correct proportions would have the same appearance under the same conditions. The appearance itself will be determined by a number of factors, such as the adaptation level and the conditions of contrast; thus when the intensity of a beam of light such as a spectral red or spectral green radiation is increased, the quality of the light appears to change in the direction of becoming whiter. These changes are due to adaptive processes in the retina and possibly in the brain, and they may lead to subtle effects which are by no means easy to evaluate.

Quite recently, however, Newhall, Nickerson and Judd[10] have studied these changes in connexion with an investigation of the spacing of the patterns in the "Munsell Book of Colour". They show, for example, that the 'constant-hue' locus in the chromaticity chart for patterns of decreasing saturation is not in general a straight line from the spectrum locus to the white point, but is a curved path, the shape of which varies from one region of the chart to another. This means that constancy of dominant wave-length does not necessarily imply exact constancy in the hue which an object appears to have. In the red corner of the chart it happens that the constant-hue locus has the same type of curvature as the blood locus, and thus tends to compensate to a small extent for the changes due to the physical dichroism of hæmoglobin, but for

other media the subjective dichroism, if that is an apt description of the phenomenon, may be equally liable to accentuate the change in hue.

[1] Baker, J. R., NATURE, 152, 331 (1943).
[2] Bowen, E. J., NATURE, 152, 476 (1943).
[3] Webb, D. A., NATURE, 152, 476 (1943).
[4] Heilmeyer, L., trans. Jordan, A., and Tippell, T. L., "Spectrophotometry in Medicine" (Adam Hilger, Ltd., 1943).
[5] Commission Internationale de l'Eclairage. Compte Rendu (Cambridge, 1931).
[6] Smith, T., and Guild, J., *Trans. Opt. Soc.*, **33**, 73 (1931).
[7] Judd, D. B., *J. Opt. Soc. Amer.*, **23**, 359 (1933).
[8] Hardy, A. C., "Handbook of Colorimetry" (Mass. Inst. Tech., 1936).
[9] Paterson, D., "Textile Colour Mixing" (Benn, 1927).
[10] Newhall, S. M., Nickerson, D., and Judd, D. B., *J. Opt. Soc. Amer.*, **33**, 385 (1943).

U.S. NATIONAL PATENT PLANNING COMMISSION

By SIR WILLIAM JARRATT

DURING the past few years there has been considerable criticism of the patent system both in Great Britain and in the United States, and the impact of war has tended to intensify it in both countries. In America the criticism has been much more violent than in Great Britain, and many Bills dealing with alleged abuses in the patent system have been introduced in Congress, though none has become law. In view of this acute criticism, President Roosevelt, by Executive Order in December 1941, established a National Patent Planning Commission authorized, in conjunction with the Department of Commerce, to conduct a comprehensive survey and study of the American patent system, and consider whether the system provides the maximum service in stimulating the inventive genius of the American people in evolving inventions and in furthering their prompt utilization for the public good; whether the American patent system should perform a more active function in inventive development; whether there are obstructions in the existing system of patent laws and, if so, how they can be eliminated; to what extent the Government should go in stimulating inventive effort in normal times; and what methods or plans might be developed to promote inventions and discoveries which will increase commerce, provide employment, and fully utilize expanded defence industrial facilities during normal times.

The first report of the Commission, which has now been published (U.S. Superintendent of Documents, Washington, D.C.) is confined generally to the mechanics of patent law, and the use of patents. In an introductory statement, the Commission points out that the strongest industrial nations have the most effective patent systems, and it expresses the opinion that the American patent system is the best in the world. It recommends, however, that the system should be adjusted to meet existing conditions without destroying its basic principles, and it makes numerous specific recommendations for amendment of the patent law of the United States.

Two questions connected with the patent law but of general interest were also considered by the Commission, namely, "Patents and the War Effort" and the "Protection of the Public Interest". On the first question the report states that specific inquiries addressed particularly to representatives of the War and Naval Departments failed to develop any serious instances in which the patent system had interfered with the prosecution of the War. The Commission expresses the opinion that the outcome of the present War, more than any previous war, will depend upon a continuous superiority in science and invention, and that "never before has there been such a free exchange of scientific and technological knowledge and products of invention between our industrial concerns, our research laboratories, and our Government, and between our Government and our Allies. Such a liberal and complete exchange of scientific information and the secrets of industrial laboratories could not have been possible without the reassurance of the protection afforded by the patent system. The American people should recognize the part the system is thus playing in the free exchange of scientific information which is proving so effective in the prosecution of the war and which is so essential to ultimate victory." It is pointed out in the report that the existing law permits the American Government and its contractors to manufacture and use any patented or unpatented invention on payment of reasonable compensation, and the evidence taken by the Commission indicates that the law is adequate to protect the Government during the present national crisis. The British Government has, of course, similar powers conferred on it, and is given similar protection, by Section 29 of the Patents and Designs Acts, 1907 to 1942, which enacts the right of the Crown to use patented inventions and sets out the procedure for determination of the royalty or other compensation payable.

The Commission considered the question of the protection of the public interest from many points of view, the most important being whether it would be in the public interest to incorporate in the law a general compulsory licensing system, that is, a system under which every patentee can be compelled to allow his invention to be manufactured or used by another person on payment of a royalty or other compensation. It was felt that such a system would affect American needs adversely and would produce detrimental effects in foreign countries; and in consequence the conclusion is reached that it would not be advantageous to incorporate a compulsory licensing system in American patent law. The Commission was, however, impressed with the need of a degree of compulsion in certain fields, such as national defence, public health, and public safety, and it recommends in respect of these cases a system whereby in an action for infringement "the recovery of a patent owner shall be limited to reasonable compensation without prohibiting the use of the patented invention". It is interesting to note that this recommendation of the Commission would bring the American law into closer agreement with Section 38 A of the Patents and Designs Acts, 1907–42, of Great Britain, which enacts that, in the case of any patent for an invention for the preparation or production of food or medicine, the Comptroller of Patents shall, unless he sees good reason to the contrary, grant to any person a licence to use the invention, and in settling the royalty or other compensation payable, the Comptroller shall have regard to the desirability of making the food or medicine available to the public at the lowest possible price consistent with giving to the inventor due reward for the research leading to the invention.

On the general question of patents, the American people and their Government are urged by the Commission to recognize the fundamental rightness and fairness of protecting the creations of its inventors by the patent grant, and the Report states that the American patent system has: (1) encouraged and

rewarded inventiveness and creativeness, producing new products and processes which have placed the United States far ahead of other countries in the field of scientific and technological endeavour; (2) stimulated American inventors to originate a major portion of the important industrial and basic inventions of the past hundred and fifty years; (3) facilitated the rapid development and general application of new discoveries in the United States to an extent exceeding that of any other country; (4) contributed to the achievement of the highest standard of living that any nation has ever enjoyed; (5) stimulated creation and development of products and processes necessary to arm the nation and to wage successful war; (6) contributed to the improvement of the public health and the public safety; and (7) operated to protect the individual and small business concerns during the formative period of a new enterprise.

In view of a report so favourable to the present American patent system, it is of interest to note that the numerous important technical changes recommended by the Commission are almost uniformly of such a nature as to bring the American patent system more closely into accord with that of Great Britain.

TRICOTYLEDONY

By H. E. HOLTORP

TRICOTYLEDONY is well known as a sporadic occurrence in dicotyledonous plants, but it has apparently been treated in the past as a rare and somewhat trivial abnormality. I have been unable to trace any evidence of its being regarded as heritable.

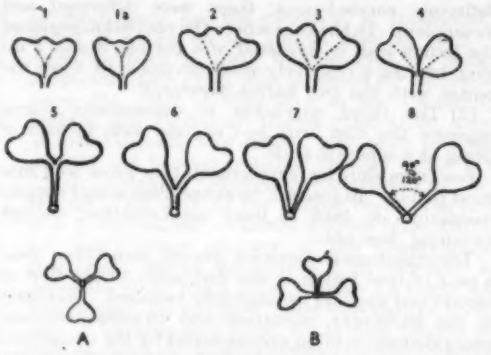
During the last few years I have collected tricotyledonous seedlings from a number of plants, the more important including various brassicas, wallflowers, *Dianthus sinensis*, carnations and carrots. These are mainly biennials, but I have also observed tricotyledony in certain annual dicotyledonous weeds and have more recently secured tricotyledonous tomatoes.

The observations, which I shall describe, have been made chiefly on brassicas (cabbage, savoy, cauliflower), for here the cotyledons are distinct in shape, substance and structure from the true leaves, even to casual inspection. This advantage is shared by tomatoes and carrots, but my investigations with these plants have not yet progressed so far.

I grew the first few tricotyledonous brassicas (generation *P*) to seed, isolated from other brassicas though not from one another. This seed yielded a considerable number of tricotyls in the S_1 generation. They were not counted, but there is no doubt that the proportion was higher than in the *P* generation. From this S_1 I selected seventeen of the most symmetrical tricotyls and again seeded them under similar conditions. The next generation (S_2) contained not only some hundreds of tricotyls, but also eighty tetracotyls—a form of which I had not seen a single example in thousands of brassica seedlings before this generation. Again I have selected and planted, in separate groups, the best tricotyls and tetracotyls for an S_3 generation in 1944.

It is thus clear that tricotyledony is a heritable character and one which can easily be changed by selection. Dicotyledony must then be adaptive and maintained by natural selection.

Pleiocotyls are not alike in form, and are not all to be traced to the same kind of variation in the seedling



structure. Seedlings must be grown to a considerable size before adequate description and classification are possible.

In brassicas I have recorded three main types of tricotyledony, each subject to its own characteristic variation, under the headings: (*a*) *simple fission*, (*b*) *twinning*, complete and incomplete, and (*c*) *supplementation*.

Fission. This appears as simple splitting of a cotyledon, from the notch in the terminal edge along the central vein towards the petiole. The split varies in length, the most extreme case seen being one of two elliptical pieces of tissue with separate stalks joined to form one petiole. Seedlings in this class are viable and grow into healthy plants, but the split cotyledon is always distorted and lags behind its normal fellow in growth.

Twinning. The diagram represents various forms of twin cotyledons and their petioles as found, together with all intermediate forms, in the brassicas. The simplest form (1) is a two-notched broad cotyledon in which the central peak is quite commonly not prominent (1*a*). The mid-vein is noticeably forked. This form is very common and is the only one which (except for true tetracotyls) occurs often in both cotyledons of a seedling. The remaining types are not infrequent though the symmetrical tricotyl (*A*) is somewhat rare, just as is a perfectly symmetrical dicotyl.

Supplementation. This variant has been quite common in the progeny of tricotyls after selection. Three main classes have been distinguished.

(1) The seedling is apparently normal and dicotyledonous, but the first subsequent true leaf, instead of being of the characteristic rough type, develops as a third cotyledon identifiable by substance, structure, venation and petiole, and even, in many cases, by its shape. It is, however, never a normal cotyledon, for its shape never changes by growth once it has developed. It grows but little after development, unlike the normal true leaf. This third cotyledon replacing the first true leaf may be (*a*) nearly but not quite a normal cotyledon, (*b*) clearly cotyledonous but incomplete, varying from the major portion of a cotyledon down to little more than the central vein, (*c*) clearly cotyledonous but with one lower quadrant, or perhaps a little more, showing a serrated edge like a true leaf, or (*d*) rarely, with about one half cotyledonous and the other more like a true leaf.

(2) The third cotyledon appears in rare cases in place of the second true leaf, after a first normal true leaf has been produced. It may even appear in place of the fourth leaf after three true leaves. Though

definitely cotyledonous, these were deformed and incomplete. In the case where the cotyledon replaced the fourth leaf, it consisted of a petiole, about 3 in. long, bearing a relatively small lamina split down the centre with the two halves divergent.

(3) The third cotyledon is occasionally borne opposite the first true leaf at one node instead of being at a separate node.

Seedlings showing supplementation grow well into good plants. In general, however, fission and supplementation do lead to local malformation, though twinning does not.

Tricotyledonous brassica plants sometimes bear a pair of true leaves at the first node, or the first or second leaf may be incompletely twinned. Similarly in the wallflower, carnation and *Dianthus sinensis*, tricotyledony is often accompanied by the occurrence of three true leaves at the first, and sometimes also at the second, node.

Thus pleiocotyledony in brassicas occurs, as I find it, in several forms, counts of which should be made in the progeny of each type of tricotyledonous parent: for the various forms can all be found among the offspring of one plant. I have estimated that the S_2 generation contained 25 per cent pleiocotyls of one kind or another, and a similar percentage has been found in a small test with the tomato. Pleiocotyly in an S_2 of wallflower, however, is as high as 40 per cent. Full analysis, however, involves growing all the seedlings to a size hitherto impossible in the conditions under which I have worked. I hope to obtain improved facilities in the future and so to obtain adequate counts in the selection lines.

I am indebted to Dr. K. Mather, of the John Innes Horticultural Institution, for advice on the interpretation of these observations.

SCIENTIFIC CENTENARIES IN 1944

By Eng.-Capt. EDGAR C. SMITH, O.B.E., R.N.

AMONG the many men of science whose centenaries occur this year are representatives of England, Scotland, Ireland, France, Belgium, Sweden, Italy, Austria and America. Four hundred years ago, according to Silvanus Thompson, Gilbert was born; three hundred years ago, Castelli, Gascoygne and van Helmont died and Römer was born; two hundred years ago Celsius and Desaguliers died and Lamarck and Mechain were born, while among those who died a century ago were Dalton, Baily, Hope, Henderson and Geoffroy Saint-Hilaire.

On December 10, 1903, the exact tercentenary of the death of William Gilbert was commemorated by a meeting of the Institution of Electrical Engineers held at the Institution of Civil Engineers, at which the Royal Society, the Royal College of Physicians, St. John's College, Cambridge, the cities of Colchester and Westminster and the Société Internationale des Electriciens were represented. The address was given by Silvanus Thompson, who said "that electricians owed an enormous debt of gratitude to Gilbert, who, for them, was pre-eminent among all the great men of Elizabeth's time". The occasion was marked by the presentation to the City of Colchester of a picture representing Gilbert showing his experiments to Queen Elizabeth and her Court. The tomb of Gilbert in Holy Trinity Church, Colchester, gives the year of his birth as 1540, but Silvanus Thompson considered the correct date to be May 24, 1544.

Van Helmont (1577–1644), like Gilbert, was a physician, and for a short time filled a chair at Louvain; but his life was spent in philosophical studies and he was the first to recognize the existence of various aeriform substances to which he gave the name 'gases'. He was born in Brussels but died in Holland. Benedict Castelli (1577–1644) was an exact contemporary of van Helmont, and had the privilege of being taught by, and assisting, Galileo; he held chairs both at Pisa and Rome. William Gascoygne (1612 ?–1644), the inventor of the micrometer and a correspondent of Horrocks and Crabtree, died at about the age of thirty, fighting on the Royalist side at Marston Moor on July 2, 1644. Olaf Römer, the Danish astronomer, was born at Aarhuus, in Jutland, on September 25, 1644, and died at Copenhagen on September 19, 1710. His discovery of the velocity of light was made in Paris, when he was thirty-one; his famous transit instrument was made at Copenhagen, where he held the chair of astronomy. Many of his manuscripts were destroyed in the Copenhagen fire of 1728. The year 1744 saw the death of both Andreas Celsius and John Theophilus Desaguliers. Celsius was born at Uppsala on November 27, 1701. His travels took him to Germany, Italy and France, and then he went to Lapland with Maupertuis to measure an arc of the meridian. According to Cajori, Celsius marked his centigrade thermometer with boiling point as 0° and freezing point as 100°, and it was his colleague Mårten Stromer who inverted the scale. Desaguliers was nearly twenty years senior to Celsius, having been born at Rochelle on March 12, 1683. He was brought to England by his father, a Calvinist pastor who left France on the Revocation of the Edict of Nantes. The child, it is said, was smuggled aboard the refugee ship in a barrel. France's loss was England's gain, for Desaguliers succeeded Keill as a lecturer on experimental philosophy at Oxford, and then in 1713 began his work in London "where," he wrote, "I have with great pleasure seen the Newtonian Philosophy so generally received among persons of all Ranks and professions, and even the Ladies by the help of experiments". At his death, Desaguliers was buried in the Savoy. Of the two Frenchmen, Lamarck and Mechain, the former was born in the village of Bazentin (Somme) and the latter at Laon (Aisne). Lamarck began life as a soldier, and then held a post in a Paris bank. In 1774 he became a keeper in the Jardin des Plantes, and there, for a quarter of a century, he lectured on invertebrate zoology. He died in 1829, blind and poor. Pierre F. A. Mechain was a geodesist as well as an astronomer and hydrographer, and it was while still employed on the extension of an arc of the meridian to Barcelona that he died on September 20, 1805.

Coming to those who died a hundred years ago, one of the most famous was Étienne Geoffroy Saint-Hilaire, who was born at Etampes on April 15, 1772, and who did great work both for the Jardin des Plantes and the Museum. In Scotland, few were better known than Thomas Henderson (1798–1844) and Thomas Charles Hope (1766–1844). Henderson, a native of Dundee, began life as a lawyer's clerk, but his studies led him to become acquainted with Wallace and Leslie, and through his papers he gained recognition as an astronomer. After a year or two at the Cape of Good Hope, on October 1, 1834, he became the first Astronomer Royal for Scotland. His contemporary, Hope, was always a chemist, and from 1799 until 1843 occupied the chair of chemistry in

the University of Edinburgh, previously held by Black. To him we owe the discovery of the maximum density of water. The centenary of John Dalton falls on July 27 of this year, but any commemoration must inevitably be clouded over by the results of the air raid of December 24, 1940, when the premises of the Manchester Literary and Philosophical Society were completely destroyed. From 1817 until 1844 Dalton was president of the Society, and within its walls he taught, lectured and experimented. The Society had an unequalled collection of his apparatus, but after digging among the ruins the only things found were his gold watch, a spark eudiometer and some charred remains of letters and note-books. A month after Dalton passed away in Manchester, Francis Baily died in London, after a life devoted to astronomy and kindred subjects. "Few men have left behind them so enviable a reputation. He was gentle as well as just; he loved and sought truth; he inspired in an equal degree respect and affection."

As is usual in these annual reviews of the centenaries of men of science, names of notable men born a century ago crowd closely upon one another, but it will perhaps be agreed that all those mentioned below have claims to recognition. Among the ranks of the physicists born in 1844 were Sir William F. Barrett (died 1925), who for more than thirty years held a chair in the Royal College of Science, Dublin; Sir William Abney (died 1921), who did much to put photography upon a scientific basis; and Ludwig Boltzmann (died 1906), professor of mathematical physics in the University of Vienna. Boltzmann died a tragic death, and his successor, F. Hasenöhrl, was killed in action on the Italian front in 1915. The chemists born in 1844 include Prof. J. Emerson Reynolds (died 1920), who occupied for twenty-eight years the chair of chemistry in the University of Dublin, and Ferdinand Hurter (died 1898), a native of Schaffhausen, Switzerland, who came to England in 1867 and became principal chemist to the United Alkali Company. Among astronomers, Prof. W. R. Brooks (died 1921) of the United States was famous as a 'comet hunter'. Charles Trépied (died 1907) was for many years director of the Observatory at Bouzariah, eleven kilometres from Algiers, while Annibale Ricco (died 1919), though he began life as an engineer, for nineteen years directed the observatory of Catania and Etna, his special subject being solar physics. In another sphere of scientific activity, Henry Alleyne Nicholson (died 1899) held professorships at St. Andrews and Aberdeen, and was Lyell medallist in 1888, while Auguste Michel-Lévy (died 1911) was director of the Geological Survey of France. A notice of the life and work of Michel-Lévy was read at a sitting of the Paris Academy of Sciences on December 21, 1914, under the shadow of war. The opening sentences ran, "Aux heures les plus graves de notre histoire nationale, l'Académie des Sciences a toujours tenu à proclamer bien haut sa foi inébranlable dans les destinées de la Patrie en n'interrompant en rien l'ordre régulier de ses travaux. C'est pourquoi, alors que notre territoire est encore envahi par l'ennemi, l'un de vos Secrétaires perpétuels vient, comme de coutume, vous rappeler en cette séance annuelle le souvenir de l'un de nos confrères disparus."

OBITUARIES

Sir Edward Poulton, F.R.S.

EDWARD BAGNALL POULTON, who died on November 20, was born on January 27, 1856. His school life was spent at Oakley House, Reading, until he was nearly seventeen, when he commenced work in the office of his father, who was an architect. His interest, however, was so obviously in science that he was allowed to work for a scholarship, attending Rolleston's lectures at Oxford. He obtained an open scholarship in science at Jesus College in 1873, and after a crowded three years took a first class in the honour school of natural science. Next year he was appointed demonstrator in zoology under Rolleston, whose virile personality greatly impressed him. But working as one of his staff under him was a very different thing from being one of his students, and Poulton could do little research. During the long vacation, however, he was inspired by Foster and Balfour's work on embryology to follow their methods, and as a result was given a class to teach in that subject. His income being inadequate, he studied for a University scholarship in geology under Prestwich, eventually obtaining the Burdett-Coutts Scholarship. Thus it came about that, having resigned his demonstratorship, his first research was conducted on a geological subject, and his first paper was published in 1880 on remains in quaternary sands at Reading.

Rolleston was succeeded by Moseley in 1881 and Poulton, by now lecturer at Keble and Jesus Colleges, found him as helpful as Rolleston had been difficult. Moseley suggested that he should investigate some *Challenger* material, and as a result of his studies three papers were published in 1883 on the tongues of several Australian animals, including Ornithorhynchus. An investigation of the structure of the hair of this primitive creature then followed, sections of the head of an immature specimen having been lent by Dr. W. K. Parker. This resulted in a discovery of fundamental importance, for Poulton announced in 1888 that Ornithorhynchus possesses true teeth which cut through the gums but are replaced by horny plates.

But although he was professionally occupied with morphology, Poulton's real interest was in living insects. Such entomological studies as he saw being conducted by Westwood at Oxford did not, however, appeal to him, for they were concerned mainly with systematics. Poulton had read Wallace's essays on natural selection in 1878, and these aroused what he described as "a lifelong delight" in the subject of the coloration of animals, particularly of insects. Weismann's studies in the theory of descent, of which he read in 1883 a translation by his friend R. Meldola, contained an account of variation in the colour of a caterpillar according to its surroundings, which especially interested Poulton, as it recalled observations he had made in boyhood upon that very species.

He began to work at once on that subject, and, amidst his morphological work, produced during 1884–88 a succession of papers on the colours of larvæ and pupæ and on experiments to test the factors influencing them, and their survival value. These researches led to his election to the Royal Society in 1889, and in 1890 his great work "The Colours of Animals" at once set him in the front

rank of upholders of natural selection, and until recently held the field as a comprehensive guide to the meaning of all forms of coloration. He became known as an ardent champion of pure Darwinism, finding in it a satisfying explanation of countless phenomena of colour and habits which, he always emphasized, must be studied and explained together. He first read "The Origin of Species" in 1875 as an undergraduate, and throughout his life it was almost like a Bible to him. He explained, in two books, the principles on which it was based, to aid those who, perhaps, felt the masterpiece rather too much for them.

The extravagant claims of the early mutationists particularly distressed Poulton, and he fought against the idea which Sir Oliver Lodge neatly expressed at the British Association in 1913—that not only is it untrue to say '*Natura non fecit saltum*' but that it is doubtful if she ever does anything else. Partly, perhaps, for this reason and partly because mathematics were as incomprehensible to him as to the master he served, he was never attracted by genetics, though heredity greatly interested him, and he took much interest in eugenics.

The death of Westwood left vacant the recently founded chair of Hope professor of zoology at Oxford, and Poulton was elected to it in 1893: there could scarcely have been a greater change. Westwood had been mainly occupied in the prevalent mode of adding to knowledge by describing new species and classifying them. In this he won world renown, but he did not move with the times, and warned Poulton against the dangers of the new doctrine. It was an irony that the young man so warned became one of its most forceful exponents. One of the first applications of Darwinism to problems of field natural history was the theory of mimicry, propounded by Bates in 1862, which explained the deceptive, superficial resemblance of one species of butterfly to another better protected by unpleasant qualities against the attacks of predators. Mimicry became one of Poulton's chief subjects, and all that he and his friends did to make known the extent of the phenomena convinced him that no explanation covers all the facts so well as natural selection. Critics have not always troubled to understand thoroughly the problems involved in minicry, and it is a pity that the logical terms which Sidgwick devised for Poulton ("pseudaposematic" and "synaposematic") are not more generally used. If these types of coloration are due to selective preferences of predators, then upholders of the theory must produce evidence, and Poulton continually urged naturalists to observe and experiment in the field. A large body of facts has thus been accumulated, but it is not unfair to say that Poulton was not statistically minded; and most of the records, while adding more and more instances of observed cases, are not satisfying to the inquirer into "*How much* better?" or "*How much* more often?"

It was one of Poulton's correspondents who first showed that, when a bird attacks a butterfly and releases it, the shape of the bill is recognizably imprinted upon the wing, and much work on this subject has been done which goes to show that birds are probably the selective agents which theory requires for the production of mimicry in butterflies. On the other hand, if vertebrates avoid certain species as relatively distasteful, it is possible that these are destroyed by insect predators, and this point was also urged by Poulton, and evidence shows that this is so.

The importance of the fact that 'edibility' is relative, and merely a function of abundance, is frequently overlooked by critics. This point was emphasized by Poulton. The value of mimicry closely depends upon geographical distribution, and studies made by Poulton and his associates have shown that in such remarkable polymorphic species as *Papilio dardanus* and *Pseudacraea eurytus*, the prevailing form of the mimetic species corresponds numerically with the species of model most abundant in the locality. Moreover, if the protective influence of a model is removed by its decline in numbers, or by the mimetic species occurring in localities from which models are absent, the mimic is uncontrolled by selection and the mimetic resemblance deteriorates.

A Darwinian may be expected to show interest in sexual selection, and Poulton's influence resulted in important discoveries of structures used to produce scent in courtship, and of habits displaying special colours before the female. The extraordinary behaviour of certain male flies (Empididæ), closely studied by one of his assistants, was shown to constitute a complete evolutionary series in the development of an elaborate courtship.

All this involved immense labour in correspondence, but there was also the care of the great collections which grew embarrassingly, so that it became beyond his power to attend to every detail himself, and he was very insistent upon detail; thus to anyone but Poulton himself there seemed to be considerable confusion. He paid particular attention to making a label tell the whole story of a specimen, so that Hope Department labels are recognized to be the most informative in any collection in the world. But his passion for making the title of a communication summarize all the contents often proves a trial to bibliographers.

After his retirement in 1933, Poulton's friends hoped that, freed from the care of the department which he had made renowned, Poulton would settle down to the production of his *magnum opus*, but this was not to be. He was unable to shake himself free from the toils of correspondence; his powers weakened, his memory began to fail, and kindly death took him peacefully while he was still happy and interested.

His distinctions were many. He served on the Council of the Royal Society during 1897–99 and 1908–10; was vice-president during 1909–10 and Darwin medallist in 1914. He presided over the Linnean Society during 1912–16 and was Linnean medallist in 1922. When the second International Entomological Congress met at Oxford in 1912, he was its president; in 1915 he gave the Romanes Lecture. He thrice presided over the Entomological Society, the last occasion being at the centenary meeting in 1933, at which it became a Royal Society. Several universities, at home or abroad, conferred honorary doctorates upon him, and he was an honorary member or correspondent of many learned societies.

Friendly, affectionate and uncompromisingly truthful, he was a great believer in intercourse and a habitual attendant at the British Association meetings, at which he presided in 1937 and with which he went to South Africa and Australia. He also visited North America, and everywhere established links of closest friendship. He married in 1881 Emily, daughter of George Palmer, formerly M.P. for Reading, who predeceased him. They had two sons and three daughters, of whom only Mrs. Maxwell Garnett

survives him. There are thirteen grandchildren and three great-grandchildren to carry on his memory.

By the death of Sir Edward Poulton, natural history, as Darwin taught it, has lost a master. He will long be remembered for his life's work at Oxford; from it has flowed inspiration and help to naturalists seeking truth all over the world. They found him a never-failing counsellor and a generous friend whom they learnt to love. G. D. HALE CARPENTER.

Mr. H. F. Witherby, M.B.E.

THE death of H. F. Witherby on December 11 leaves a gap in the students of British ornithology which will be difficult to replace. He was the second surviving son of Henry Forbes Witherby of Burley, Hants, and was born on October 7, 1873. After leaving school he entered the old family publishing firm of Witherby and Co., and some years ago retired, but resumed work again after the outbreak of war.

Although a successful business man, the study of birds was Witherby's main interest in life, and for this purpose he made many trips abroad in search of birds. He was specially interested in Spanish ornithology, and contributed several papers on this subject to the *Ibis*. Early in his career Witherby became interested in migration, and with the object of studying this phenomena visited many well-known localities on the east coast, and in 1938 even venturing to Fair Isle.

In 1909 he started the 'British Birds' ringing scheme, which from a small beginning has grown to be of national importance and is now carried on from the British Museum under the auspices of the British Trust for Ornithology. In 1907 he founded *British Birds* magazine, and this soon brought him in touch with all those interested in the study of birds in these islands. With the help of others he published a "Handlist of British Birds" in 1912, and in 1912–24, with the assistance of other ornithologists, a "Practical Handbook of British Birds". When these volumes became out of print he published during 1938–41 a more ambitious work, the "Handbook of British Birds", in five volumes; this has rightly been described as the best book on the birds of any country. Witherby himself was responsible for the systematic work and general editorship.

He had a very fine collection of both British and European birds which he sold to the British Museum, giving the proceeds to the British Trust for Ornithology, a body he took great interest in from the beginning. His collection was very carefully made, mainly for the purpose of studying races and plumages. Together with the late Dr. C. B. Ticehurst he did much to elucidate the moults and sequence of plumage of our native birds—indeed it might be said of European species also. It was Witherby who cleared up the long-disputed question as to how the rook developed its bare face, and in an article in *British Birds* proved it was a matter of age, not wear. Witherby was a very careful and painstaking worker, and would take an enormous amount of trouble before admitting a new species to the British list, or a record of a rare visitor. The late Dr. Hartert may be said to have introduced the trinomial system into ornithology in Great Britain, and Witherby was one of the first to appreciate the importance of this step.

As editor of *British Birds*, Witherby occupied a unique position in the study of our native birds, and he will be sadly missed by his many friends and correspondents; to beginners he was especially helpful and encouraging. During 1924–27 he was chairman of the British Ornithologists' Club, and president of the British Ornithologists' Union during 1933–38. On his retirement he was awarded the Godman-Salvin Medal for his work on ornithology.

In 1904 he married Lilian, daughter of the Rev. S. Gillson, and leaves two sons and three daughters.

N. B. KINNEAR.

NEWS and VIEWS

Secondary Education in Great Britain

THE valuable statement "The Open Door in Secondary Education", issued by the members of the Education Sub-Committee of Nuffield College Social Reconstruction Survey, does full justice to the twin aims of educational reform: maintenance of the quality of the education provided, while making sure that opportunities at present the privilege of a minority become the heritage of the nation. Its six recommendations are accompanied by a brief survey which indicates the rapidity with which opinion has advanced in this field. First, the Statement recommends that in all schools which receive any grants from the State or from local education authorities, tuition should be free and adequate maintenance grants should be given. Secondly, the scales on which grants are made to schools should vary according to the education they provide, especially in equipment, staffing ratio and opportunities for advanced work. To deal with the allocation of grants and with the question of control involved in this second recommendation, establishment by the Board of Education of a school grants central committee on the lines of the University Grants Committee is proposed, assisted by a small number of regional committees.

All schools for children between the ages of eleven and eighteen should be inspected by the Board of Education at intervals of not more than five years. All private schools which have not yet been formally recognized should be required to obtain from the Board a certificate of efficiency: but no school should be closed by the Board of Education without the right of appeal to an independent tribunal. One member of the Committee, Sir Richard Livingstone, regards this proposal as too drastic and open to abuse, and would tackle the evil of the undesirable school by giving a certificate to schools which submit to voluntary inspection and are approved, or by refusing anyone leave to teach who does not hold a university degree or has not attended an approved course for training in teaching.

The Statement then recommends that the school grants committee and the local education authorities should be empowered to make grants to children to enable them to pass from schools under their jurisdiction to independent private schools if they secure places in them. Maximum grants should be fixed by the school grants committee. Finally, such grants should only be made to children entering schools which observe the following conditions to the satisfaction of the Board of Education: (*a*) that to the extent of their normal numbers they admit children

according to their capacity to profit by the education provided, and not according to their parents' needs; (*b*) that the schools provide from their own resources any sums needed above the maximum grants specified to pay the fees for any pupil they admit who may need further assistance; and (*c*) that the schools devise or accept tests of suitability for entry with enough options to enable children who have had different types of early education to show ability to profit by the education given in the schools.

Scientific Men in Government Service

ALTHOUGH the article "Science and Government" by Dr. H. G. Moulton, president of the Brookings Institution (published in *Science* of December 11, 1942, which has just been received), is mainly concerned with relations between scientific workers and the Government of the United States, it is of some interest with regard to current discussions in Great Britain on the place of science in government. Dr. Moulton covers a wide field, including scientific research into the machinery of government as well as the conduct of scientific research by government and the use of scientifically trained men by government, and he suggests that the surest means of resolving the prevailing confusion of our time and of finding solutions to the baffling problems now confronting civilization lies in a re-integration of knowledge through the systematic study of the various fields of science conceived as a whole. This is the primary function of the university, but the failure of the U.S. Government to make more effective use of science in the determination of policy is attributed to shortcomings in the organization of the American system of government and politics. Dr. Moulton points out that while the scientific men in government departments may assemble the data required with true scientific objectivity, they are usually debarred from interpreting the data or formulating conclusions to be drawn therefrom. There is no easy road to efficiency in government. Scientific men, business men and the general public must take an active and continuous interest in government, keeping themselves informed on the issues involved and electing honest, public-spirited and able servants. Public office-holding must be made a high calling, a worthy and rewarding career for anyone, and representatives must be encouraged to think in terms of the national welfare as a whole, rather than in terms of sectional or local interests.

Sugar Research Foundation

DR. ROBERT C. HOCKETT, associate professor of organic chemistry at the Massachusetts Institute of Technology, has been appointed scientific director of the Sugar Research Foundation. Following his graduation from Ohio State University, Dr. Hockett served there as graduate assistant in analytical chemistry. As a fellow of the National Research Council, he went to the National Institute of Health, United States Public Health Service, where he worked with Dr. C. S. Hudson. Dr. Hockett later became associate technologist of the Institute of Health and served in that position for several years. Since 1935, Dr. Hockett has been at the Massachusetts Institute of Technology, where he has developed a research programme on the chemistry of carbohydrates. Mr. Joseph F. Abbott, president of the Sugar Research Foundation, said that this appointment is the first step in a new scientific programme to extend knowledge of the role of sugar and other carbohydrates in the human body and also of the chemical transformations to which sugars can be subjected. It is anticipated that such chemical studies, both fundamental and applied, will eventually indicate new industrial uses of sugar and its derivatives. Dr. Hockett has been granted five years leave of absence from the Massachusetts Institute of Technology to carry on his new work with the Foundation.

Mr. Abbott pointed out that the aims of the Sugar Research Foundation, which is a non-profit organization with offices at 99 Wall Street, New York 5, N.Y., and was formed last June, include the promotion of research and scientific studies at universities and other research institutions on the uses of sugar, and the dissemination of accurate information concerning sugar. It is supported by cane sugar refiners and beet sugar processors, as well as raw sugar producers of Hawaii, Louisiana and Puerto Rico. It is believed that research on the proper balance between carbohydrates and other food elements in the diet will do much to aid the public in utilizing intelligently low-cost energy foods, such as sugar. This will be of obvious importance during the present period of world-wide food shortages, and for some time after the cessation of hostilities, when populations will have to be fed on diets containing a high proportion of sugars and other carbohydrates.

Development Advisor for West Africa

THE Secretary of State for the Colonies has appointed Mr. N. F. Hall, director of the National Institute for Economic and Social Research, to be development advisor for West Africa. He will be on the staff of the Resident Minister and will act in close consultation with the Governments of Nigeria, the Gold Coast, Sierra Leone and the Gambia, which have been working for some time on plans for post-war development. Mr. Hall has been on leave of absence from the National Institute since 1938 for war duties, and has served as joint-director of the Ministry of Economic Warfare; and more recently has been in charge of economic warfare work at the British Embassy, Washington, where he held the rank of Minister in the Diplomatic Service.

Mr. Maxwell Fry has been appointed town-planning advisor to the West African Governments; he will assist in the preparation of schemes for the large-scale housing and town-planning which is contemplated by these Governments.

Welsh Secretary of the Ministry of Agriculture

MR. J. MORGAN JONES, registrar of the University College of Wales, Aberystwyth, has been appointed Welsh Secretary of the Ministry of Agriculture in succession to Dr. C. Bryner Jones as from March 31, 1944. Mr. Morgan Jones is the son of a Montgomeryshire farmer, and a former student of the University College of Wales, Aberystwyth. In 1924 he joined the staff of the newly established Advisory Department in Agricultural Economics of the College and remained as a member of Prof. A. W. Ashby's staff until 1930. In that year he was appointed to the Markets Division of the Ministry of Agriculture. He returned to Aberystwyth at the end of 1935 to become registrar at his old College. During the War he has been closely connected with the food production campaign in Wales in the capacity of Minister's liaison officer for the counties of Cardigan, Pembroke, Carmarthen, Brecon and Radnor, and more recently

also as chairman of the Cardiganshire War Agricultural Executive Committee. Dr. Bryner Jones will continue to act as one of the Minister's liaison officers for Wales.

Veterinary Surgeons and Military Service

A JOINT statement was issued by the Ministry of Labour and National Service and the Ministry of Agriculture and Fisheries on October 5 announcing the setting up of the Army Service Veterinary Selection Committee to advise the Ministers concerned on the recruitment of veterinary surgeons for military service in their professional capacity. In order to provide full representation of the interests of veterinary surgeons in private practice, an additional member representing the National Veterinary Medical Association has been appointed to the Committee. This Committee has considered the cases of veterinary surgeons who have graduated since January 1, 1940, and who at present comprise the 'pool' from which the men needed for service in the R.A.V.C. will be recruited as required. Notifications of the Committee's decisions in these cases are being sent to the assistants concerned and also to their employers. It is expected that the number of veterinary surgeons thus made available to the R.A.V.C. will go some way, at least, to meet immediate needs. It is essential, however, in order to meet urgent military contingencies, to have a reserve of veterinary surgeons who may be drawn upon when necessary. It has accordingly been decided that the 'pool' shall be extended to include all veterinary surgeons born on or after January 1, 1914. The cases of these men will be dealt with on their merits, in accordance with the arrangements set out in the earlier announcement.

Economic Flux Density in Large Transformers

IN a paper read before the Institution of Electrical Engineers in London, D. J. Bolton pointed out that technical developments may at any time make it possible to increase the working densities in electrical machines and so enable a larger output to be obtained from a given frame-size and weight of active materials. The present paper assumes that an increase of transformer flux density is technically feasible, and tries to discover whether it is economically desirable. Only a single situation is examined, and only two, fairly large, sizes of transformer, such as would be used in the lower-voltage sections of the British Grid, are considered. The results are emphatically against any such increase, and in favour of densities lower than those in use at present.

Edible and Poisonous Plants of the Pacific Islands

A SMALL technical manual, prepared by Dr. E. D. Merrill of Harvard University, has been issued by the War Department of the United States, giving descriptions of the "Emergency Food Plants and Poisonous Plants of the Islands of the Pacific" (T.M. 10-420. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.). Although the manual is intended "to aid the individual who becomes separated from his unit" to sustain himself, it has a wider field of interest. More than a hundred of the more common edible tropical plants are figured, and each is accompanied by a short description with notes as to what parts may be eaten and how they should be prepared, together with a list of the plant names in local tongues. Nearly a dozen of the more virulent poisonous plants are also included. The simple, clear habit drawings are admirable. Occasionally human figures are included to indicate the scale, a practice which, perhaps, might have been followed more often. However, the whole makes an excellent handbook.

The Night Sky in January

FULL moon occurs on Jan. 10d. 10h. 09m. U.T., and new moon on Jan. 25d. 15h. 24m. The following conjunctions with the moon take place: Jan. 6d. 18h., Mars 8° N.; Jan. 8d. 04h., Saturn 2° N.; Jan. 13d. 11h., Jupiter 0·7° S.; Jan. 22d. 21h., Venus 2° S.; Jan. 22d. 23h., Mercury 0·1° S. The following occultations of stars brighter than magnitude 6 take place: Jan. 4d. 16h. 14.6 m. ξ^2 Ceti (*D*); Jan. 8d. 19h. 31·8m., 64 Orio (*D*); Jan. 9d. 00h. 52·5m., 68 Orio (*D*); Jan. 15d. 04h. 15·1m., 308B Leon (*R*); Jan. 16d. 05m. 03·9s., b Virg (*R*). The times refer to Greenwich and *D* and *R* refer to disappearance and reappearance respectively. Mercury is in inferior conjunction on Jan. 8. In the middle of the month it rises and sets an hour before the sun, the times at the end of the month being 6h. 27m. and 14h. 29m. Venus, a morning star, rises at 4h. 37m., 5h. 12m., and 5h. 44m. at the beginning, middle and end of the month respectively. Mars, in the constellation of Taurus, is stationary on Jan. 10. The planet can be seen through a great part of the night, being due south at 21h. 30m., 20h. 34m., and 19h. 42m. at the beginning, middle and end of the month, the times of setting on the corresponding dates being 5h. 45m., 4h. 50m., and 4h. Jupiter, in the constellation of Leo, rises at 20h. 07m., 19h. 04m. and 17h. 50m. at the beginning, middle and end of the month and is visible throughout the night. Saturn, in the constellation of Taurus, sets about an hour later than Mars at the beginning and middle of the month, and on Jan. 31 it sets at 4h. 39m. The earth reaches perihelion on Jan. 4, its distance from the sun being then 91,447,000 miles. There will be a total eclipse of the sun on Jan. 25, partly visible as a partial eclipse at Greenwich. The eclipse begins at Greenwich on Jan. 25d. 16h. 29m., but the magnitude of the eclipse will be only about 1/50, and this will occur about sunset. The Quadrantid meteors are due on Jan. 3 and 4; the radiant of this shower is at R.A. 15h. 20m., Dec. + 50°.

Announcements

THE Council of the British Cotton Industry Research Association announces that Dr. F. C. Toy has been appointed to succeed Sir Robert Pickard, who is relinquishing the post of director of research which he has filled for the last seventeen years. Dr. Toy has held the position of deputy director of the Association since he joined the Shirley Institute staff thirteen years ago. Dr. D. W. Hill has been appointed to succeed Dr. Toy as deputy director. Sir Robert Pickard has accepted the post of consultant to the Association.

ERRATUM. In connexion with the paragraph on the Duddell Medal award to Mr. J. Guild in NATURE of December 11, p. 686, reference was made to Mr. Guild's work on the improved goniometric spectrometer in collaboration with "the late Mr. George Watts". We are informed that Mr. Watts is still chairman of Messrs. E. R. Watts and Son, Ltd., and takes an active part in the daily work of the firm's factory.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Structure of Nucleic Acid in the Dividing Cell

RECENTLY Donovan and Woodhouse[1] advanced a speculation on the nature of the chemical structure which is the essence of the malignant cell. Their idea is the formulation of a molecule in the chromosome capable of splitting into two similar symmetrical portions, and this is envisaged specifically as a nucleic acid linked through pyrophosphoric acid to nucleotide groups. It is a moot point whether or not they are justified in regarding nucleic acid as the 'master constituent' to the exclusion of other known nuclear components. In this communication, however, it is desired to emphasize certain points concerning the chemistry of nucleic acids which arise from their communication.

Donovan and Woodhouse suggest that "when engaged in ordinary cellular activities, the cell has, as its essential basis, molecules of nucleic acid joined by pyrophosphoric linkings to nucleotides similar to" co-dehydrogenase I, thiamine pyrophosphate, riboflavine-adenine dinucleotide and phosphagen "which subserve its normal metabolic activity. When cell division is about to take place the metabolic nucleotides on one side of the linkage are replaced by, or are converted into, nucleotides which are the mirror image of those on the primary nucleic acid portion. The symmetrical, double nucleic acid then splits, with resultant division of the chromosomes accompanied by the associated phenomena which comprise 'cell division'. In the case of the malignant cell, however, [they postulate that] the symmetrical development of the dual nucleic-acid molecule proceeds directly and continually instead of via the usual attachment of the metabolic type of nucleotide groups."

The use of the phrase 'mirror image' is unfortunate, since it implies that the new molecule of nucleic acid will be the enantiomorph of the original. This would involve the existence of a molecule of nucleic acid differing profoundly from the original in its stereochemical structure, and as a consequence the two daughter chromosomes would be different, not identical, as is in fact the case in cell mitosis. Further, no nucleic acids containing enantiomorphic sugars have so far been recorded.

The structural diagram given by Donovan and Woodhouse for their proposed double nucleic acid is entirely without experimental basis since, so far as is known, no nucleic acid contains both pentose and desoxypentose sugars in the same molecule. It would, however, have been reasonable to assume that the nucleic acid entering into the cellular reactions postulated would be desoxyribonucleic acid, in view of the claims by Caspersson and others that it is comprised in the chromosomes.

Although it is true that the pyrophosphate group is common to several naturally occurring nucleotides, there is no evidence of its presence in isolated ribo- or desoxyribo-nucleic acids. That does not, of course, exclude the possibility of its occurrence in the living nucleus, but it should be realized that, in the formulation of the double nucleic acid by Donovan and Woodhouse, there are no dissociating groups in the phosphoryl radicles; such groups are generally regarded as participating in the union with the basic protein to form the nucleoprotein.

It is felt that, although simple chemical interpretations of the dividing chromosome and the malignant cell are much to be desired, it is unwise at present to attempt to limit consideration to one cell constituent alone. Furthermore, interpretations must be based on well-established facts, both biological and chemical, and simplification of the problem must not assume such importance that those facts are subordinated to it.

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Nov. 27.

[1] Donovan, H., and Woodhouse, D. L., NATURE, 152, 509 (1943).

Aerial Disinfection

THE bactericidal action of propylene glycol vapour against air-borne bacteria has been recently discussed by Robertson[1]. The considerations he puts forward seem capable of general extension.

In order to kill bacteria suspended in the air, a lethal amount of the bactericidal agent must accumulate on the bacteria-carrying particles. The purely physical processes involved in this are at least as important as the bactericidal power of the substance itself. Condensation of the bactericide on to the bacterium will be favoured by: (*a*) saturation or near-saturation of the air with the bactericide; (*b*) solution of the bactericide in the bacteria-carrying particles, which may usually in this context be regarded as a watery solution. When equilibrium between the particle and the bactericidal atmosphere is established, the partial vapour pressures of bactericide and water in the atmosphere and over the particle will be equal. This equilibrium will be attained very rapidly with particles of a few microns in diameter. Death of the bacteria will follow if the concentration of bactericide in the final solution is lethal.

Working on this basis, desiderata for an aerial antiseptic would seem to be, in addition to bactericidal activity and lack of toxicity to man: (*a*) low vapour pressure, so that it is possible to work near to saturation; (*b*) water solubility, so that the bactericide will condense readily on to moist particles; (*c*) stability in room atmospheres, that is, freedom from liability to oxidation or other chemical decomposition, or to absorption by walls and textiles.

In addition to the phenols and the glycols, other classes of compounds appear likely to contain members fulfilling these conditions, for example the hydroxy acids or the amino alcohols. Tests have been made on the bactericidal activity of vapours of lactic acid, mandelic acid and triethanolamine. All these have given good kills of the organisms of sprayed saliva (*S. salivarius* and others) at concentrations of 10, 8 and 150 mgm./cu. metre respectively with relative humidities about 70 per cent and temperatures of 60–70° F.

More detailed experiments have been carried out with lactic acid, and good kills (better than 90 per cent in 5 minutes) have been obtained on the organisms of sprayed saliva at relative humidities ranging

from 40 to 85 per cent and on dust from a hospital blanket, mainly carrying a sarcina, at humidities of 60–80 per cent. Both heat volatilization of the pure acid, or its aqueous solution, and dispersal as a fine spray in aqueous solution, produce bactericidal atmospheres when the acid is in a concentration of 10 mgm./cu. metre; at one third of this concentration it is much less effective. The majority of the tests were carried out in an 800 cu. ft. room at 60–70° F. and the bacteria sampled on to serum agar plates in a slit-sampler[2]. The kill was confirmed by collecting the bacteria directly into broth in an impinger and plating out.

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Dec. 11.

[1] Robertson, O. H., *Science*, **97**, 500 (1943).
[2] Bourdillon, R. B., Lidwell, O. M., and Thomas, John C., *J. Hygiene*, **41**, 197 (1941).

A Thermolabile Accessory Growth-factor to Rhizobium

IN addition to the thermostable accessory growth-factor (Allison and Hoover's coenzyme *R*), we have found a thermolabile accessory growth-factor to the root-nodule bacteria.

The medium was prepared by grinding 20 gm. of air-dried vetch powder (stem and leaves of *Vicia sinkiangensis*) with 20 c.c. normal caustic potash solution; when well rubbed, the paste was put into a cylinder containing 1,000 c.c. distilled water and was kept overnight. Next morning the supernatant fluid was transferred to a clean container, to which was added enough phosphoric acid to neutralize the alkali, and also 10 gm. sucrose and 3 gm. calcium carbonate. The resultant medium was then made up to 1,000 c.c., sterilized either by autoclaving for 25–30 minutes at 15 lb. per sq. in. pressure or by filtering through a Chamberland *F* (*L5*) candle attached to a filtering press. The autoclaved medium was distributed in 9-c.c. portions to test tubes before sterilization. The filter-sterilized medium was transferred to sterile test tubes aseptically after filtration.

Nodule bacteria strains 107 (of pea group) and 520 (of cowpea group) were used as test organisms. The inoculum was made up by washing a slant culture of the organism with approximately 10 c.c. of sterile water. A loopful of bacterial suspension was inoculated to each tube. The cultures were incubated at 25–30° C. for five days or more. Table 1 shows a typical result, in which cold sterilized medium gives more than three times the growth on autoclaved medium. Repeated experiments of the same kind established the presence of a thermolabile accessory growth-factor, stimulant, though not necessary, to the growth of root-nodule bacteria.

TABLE 1. DIRECT MICROSCOPICAL COUNT OF 11 DAYS BACTERIAL GROWTH (STRAIN 520) IN MILLIONS PER C.C.

Autoclaved medium	Cold-sterilized medium
31·5	114·0

A second series of experiments was then carried out to investigate the response of the thermolabile factor to heating. Test tubes containing cold sterilized vetch extract medium were heated for 30 min. at 40°, 60°, 80° and 100° C. in a water bath. In addition, unheated tubes and autoclaved tubes containing the same medium and autoclaved tubes containing the standard yeast-water-sucrose medium were included for comparison. Table 2 gives results of one experiment of this kind. The result shows that bacterial growth diminishes with increasing heating of the medium prior to inoculation, while there is no definite thermo-inactive point. The cowpea bacteria strain 520 seemed to have responded more readily to the thermolabile factor than that of the pea bacteria strain 107.

TABLE 2. DIRECT MICROSCOPICAL COUNT OF 5 DAYS BACTERIAL GROWTH IN MILLIONS PER C.C.

Strain	Yeast-water-sucrose	Autoclaved	Vetch extract medium				Not heated
			100° C.	80° C.	60° C.	40° C.	
520	139·1	0·6	44·8	43·6	59·2	71·5	128·0
107	143·6	78·6	85·2	119·0	105·3	130·2	126·1

Owing to the very poor laboratory equipment at our temporary war-time quarters, which are without a refrigerator to keep stock medium, and with crude chemicals, we were not able to give reproducible quantitative data between two independent sets of experiments. Nevertheless, within each individual experiment, the presence of a thermolabile factor which affected the growth-rate of root-nodule bacteria was unmistakable.

Further studies on this newly found factor are under progress so far as facilities and time permit.

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Localization of Vitamin C in *Belascaris marginata*

THE distribution of vitamin C in many vertebrate tissues is now well known, but excepting the Protozoa, knowledge of its localization in invertebrate tissues is somewhat limited, and no work, to our knowledge, has been carried out on the Nematoda.

Fig. 1.

Using the usual silver nitrate–acetic acid technique (for the validity of which see Barnett and Bourne[1]), we have investigated the localization of vitamin C in the tissues of *Belascaris marginata*. In specimens taken from dogs fed on a normal mixed diet, we have shown that a large aggregation of vitamin C can be demonstrated in the walls of the intestine. Fig. 1 shows part of a transverse section of Belascaris stained

by the silver technique. The impregnated granules are localized almost exclusively in the intestinal cells (*I*), whereas the muscular tissues (*M*) and reproductive organs (*R*) contain only very minute and scattered grains.

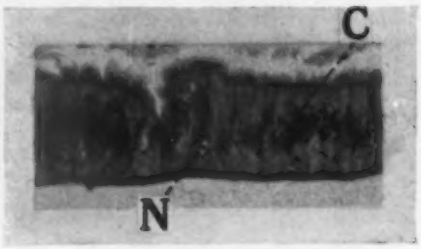

Fig. 2.

The intestinal cells are shown enlarged in Fig. 2. The deposit (*C*) is typically in the form of approximately spherical granules concentrated close to the nucleus (*N*) towards the pole nearest the lumen of the gut. It is evident, from these observations, that the parasite can absorb considerable quantities of vitamin C from the food of the host. In this way, it seems likely that the whole vitamin C metabolism of the host may be upset by the presence of the parasite. Thus it may be that in the case of heavy infections especially, absorption of vitamin C by the parasite might be sufficient to cause deficiency effects in the host. Further investigations in cases of infected hosts kept on normal and scorbutic diets may provide some interesting results.

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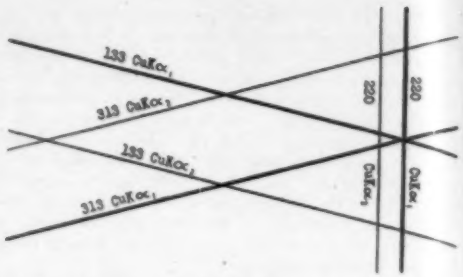
[1] Barnett, S. A., and Bourne, G., *J. Anat.*, **75**, 251 (1941).

Divergent-Beam X-Ray Photography

IN a recent communication[1] I described a simple way of taking photographs of single crystals using a widely divergent beam of X-rays, and suggested possible uses for this method.

Further study has shown that the patterns obtained from cubic crystals provide an accurate and easy way of determining the positions of the symmetry elements in crystals of unknown orientation. All that need be known is the orientation of the crystal specimen relative to the photographic plate or film. The directions of the symmetry elements are obvious at a glance on the photograph, and can be measured with ease. This is possible even if the specimen contains more than one individual.

The examination of a considerable number of diamonds has shown that divergent-beam photography with copper radiation provides a quick method of selecting type II or good type I diamonds. Type II diamonds (transparent beyond λ 3000 in the ultra-violet, and showing no extra spots or streaks on a Laue photograph apart from the usual thermal spots) give a pattern in which deficiency and reflexion (white and black) lines stand out very clearly indeed against the grey background obtainable in an exposure of a few seconds. Good type I diamonds (opaque beyond λ 3000, and giving reasonably intense groups of extra



spots and streaks on Laue photographs) give extremely bad divergent-beam photographs. The lines, when they can be seen, are very sharp, but they are barely discernible against the background. Incidentally, I have found that although out of some five hundred diamonds examined quickly with a small direct-reading spectroscope and good ultra-violet source, only one was obviously transparent beyond λ 3000, not many (6 in 28 tested) of the apparently normal 'opaque' variety gave really good type I Laue photographs. In those that did, however, the correlation between *good* extra spots and *bad* divergent-beam photographs was very striking. Although the significance of the extra spots of non-thermal origin is still obscure, a reasonable explanation of the difference between the divergent-beam photographs of the two types may be given if, as has been generally supposed, the type I are comparatively 'perfect', or, at least, monolithic in structure, and the type II are 'mosaic'. Ordinary organic crystals, such as anthracene or benzil, give quite good divergent-beam photographs.

The method has also provided a very precise determination of λ/a (X-ray wave-length in the crystal/lattice-constant) for copper $K\alpha_1$ radiation and diamond. It happens that one point of intersection of the 313, 133 copper $K\alpha_1$ conics lies very nearly on the 220 copper $K\alpha_1$ conic. The angular separation of the two is given by

$$\left[\sin^{-1}\sqrt{2}\,\frac{\lambda}{a} - \tan^{-1}\frac{2\sqrt{2}}{3} + \cos^{-1}\frac{19}{2\sqrt{17}}, \frac{\lambda}{a}\right],$$

which leads to the value $\lambda/a = 0{\cdot}431889$ for exact coincidence. On my enlarged photographs the $\alpha_1 \rightarrow \alpha_2$ separation for the 220 reflexion is about 4 mm. and the distance from the (313, 133) intersection for α_1 to the corresponding intersection for α_2 is about 6 cm. A change of lattice constant of 1 in 70,000 (0·05 X.U.) moves the point of (313, 133) intersection by about 0·25 mm. relative to the 220 line, and this is easily observable by eye. Since the method is a null one, depending only upon the almost exact coincidence of two directions in space, one of which varies rapidly with variation of λ/a, it is singularly free from any possibility of experimental error. There are no measurements that cannot be made with an ordinary ruler, and no fine adjustments to go wrong. The diamond can be orientated anyhow relative to the photographic film, and the exact crystal → film distance is immaterial, so long as the relevant 'coincidence' comes within the range of the photograph. Full details of the method will be published elsewhere.

The value of λ/a given above leads to a lattice-constant of 3·55974 kX. if the wave-length of copper $K\alpha_1$ *in vacuo* is taken as 1·537395 kX. and the refractive index for diamond as 0·999989. Individual diamonds have been found to have lattice-constants

varying over a range of about 3·55970 ± 0·00020 kX. (at 18° C.), the limits of error for any one diamond being ± 0·05 X.U. (1 kX. = 1000 X.U.). The upper limit of my measurements (3·55990 ± 0·00005 kX.) was found for a diamond which had been so blackened by heat-treatment that it was almost opaque; although its Laue photograph showed also the powder lines of graphite (the graphite flecks extending throughout the volume of the crystal) it remained nevertheless a good single crystal of diamond, type II. The lattice constants of the two types of diamond showed no consistent variation.

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[1] NATURE, 151, 52 (1943).

Secondary Non-Laue Reflexions from Phloroglucine Dihydrate

DR. LONSDALE[1] found a type of non-Laue reflexion from diamond which is different from the usual type of diffuse spots, and she mentions them as secondary extra reflexions. The spots of this type are, as distinguished from the primary type, extremely sharp for a special orientation of the crystal with respect to the incident beam, and may occasionally be drawn out into streaks as the crystal deviates from this orientation. Non-radial streaks in monochromatic X-rays have also been found by Lonsdale and Smith[2] in the case of benzil.

In a rotation photograph of phloroglucine dihydrate crystal about its *c*-axis, it was found that continuous streaks appeared connecting the spots on row lines. On oscillating the crystal through narrow angular ranges, these streaks became more prominent, but they appeared as broken short lengths corresponding to the range of oscillation. The very slow falling off of intensity along the lengths of these streaks indicated clearly that superposed on the regular crystal lattice there was an effect showing a breaking up of lattice along the *c*-axis, while along the *a* and the *b* axes the crystal was perfectly regular. That is equivalent to saying that, in the Laue equations: $a_0(\alpha_0-\alpha) = h\lambda$, $b_0(\beta_0-\beta) = k\lambda$, and $c_0(\gamma_0-\gamma) = D$, the first and the second equations remain true, while in the third there is a randomness superposed on the regular periodicity along *c*. Hence if one takes a Laue photograph with X-ray beam incident along the *c*-axis, one would expect to obtain cross-grating diffraction spots. This was indeed found on taking such a photograph. Actual calculations showed that the positions of these diffraction spots agreed accurately with those obtained from the first two Laue equations for both the copper $K\alpha$ and copper $K\beta$ radiations (except when $h = 0$ or $k = 0$), and these are extremely sharp, in fact showing the exact shape of the irradiated crystal. Laue photographs with the X-ray beam along *b* and *c* directions also confirm this breaking up of the periodicity along the *c*-axis alone.

These diffraction effects occur over and above the ordinary diffuse reflexions, which are much weaker than is usual for organic crystals, except that the reflexion corresponding to the plane (201) is very strong.

It is very remarkable that the central parts of these secondary spots are quite clear. That this is a real effect has been proved by using a number of different crystals of various sizes and from different crops. This clear centre is not present, however, in the case of the Bragg reflexions, either from oscillation photographs or Laue photographs, or in the case of primary extra reflexions. That the secondary reflexions are produced by the outer parts of the crystal and not by the central portion has been substantiated by taking a Laue photograph from a crystal cut along a diagonal as well as by allowing a very narrow beam to be incident on the central part of the crystal only. In the former case, the secondary diffraction spots are of a triangular shape with the middle of the side corresponding to the cut diagonal clear, while in the latter case these spots completely vanished.

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[1] *Proc. Roy. Soc.*, A, 179, 8 (1941).
[2] *Proc. Roy. Soc.*, A, 179, 315 (1941).

Abnormal Dissociation in Flame Gases

SOME experiments have recently been made with a flow calorimeter consisting, essentially, of a vertical water-jacketed tube fitted with a burner the height of which could be varied at will. Two similar resistance thermometers, one consisting of a plain platinum-rhodium wire and the other a quartz-coated wire, each being of the same overall diameter of 0·0005 in., were placed side by side in the gas stream. The products from the flame could be cooled to any required extent before passing the wires by raising or lowering the burner.

The results of a series of experiments with the burner at different heights to give different degrees of cooling of the flame gases are shown in the accompanying table. The mixture supplied to the burner was 25 per cent carbon monoxide plus 75 per cent air in all cases.

Experiment No.	Distance of burner to wires (in.)	Approximate time for gases to reach wires (sec.)	Quartz-coated wire temperature (° C.)	Plain wire temperature (° C.)	Difference in temp. of two wires (° C.)
1	1·5	0·2	1020	1180	160
2	3·5	0·4	960	1080	120
3	5·5	0·7	870	980	110
4	7·5	0·9	800	870	70
5	9·5	1·2	730	770	40
6	13·5	1·6	570	570	0
7	17·5	2·1	420	420	0

It will be noted that there is a marked difference in the two temperatures, the plain wire consistently giving the higher value. This is clearly due to the phenomenon of abnormal dissociation[1]. The interesting fact, however, in these experiments is that the difference in the temperatures recorded by the two thermometers persists until the gas temperature is reduced to about 500° C. This corresponds to the lapse of about 1½ sec. after combustion.

Thus it is established that abnormal dissociation can persist in flame gases when they have been subjected to considerable cooling.

The exact time and temperature at which the two thermometers will record the same temperature, thus

showing that abnormal dissociation has been eliminated, will no doubt be dependent on the geometry of the calorimeter, since this will govern the degree of contact of the flame gases with surface.

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[1] David and Pugh, NATURE, 145, 806 (1940); also David, Leah and Pugh, *Phil. Mag.*, vii, 31, 156 (1941).

A New Technique for the Ultimate Microanalysis of Organic Compounds

WE are grateful to F. B. Strauss[1] for the interest he has shown in our paper on the above subject[2], and for his trouble in giving the list of references. Our statement to which he refers was ambiguous, but this was due to editorial reduction to economize paper. In our original manuscript we stated: "We originated this unpacked tube technique for the ultimate analysis of coal. . . . So far as we are aware this was the first time it had been demonstrated that carbon and hydrogen in organic compounds could be determined by combustion in an unpacked tube. . . . we have now sought to apply our technique to the micro scale." This was altered to the form referred to by Strauss, to which we did not object since the ultimate analysis of coal is taken to imply principally the determination of carbon and hydrogen, and it has been customary to include the sulphur determination with the proximate analysis[3].

All except two of the references given, namely, those of Warren[4] and Marek[5], deal with the determination of sulphur alone, and we were fully cognizant of this work. Indeed, some of it was the basis of our present work, although in our original paper[6] we referred chiefly to its technical application by Vita[7] and Seuthe[8], who based their work on that of Mixter[9]. Presumably, Schöberl's paper[10] is the micro method referred to by Strauss, since all the other references deal with macro methods. It should be pointed out that because sulphur can be determined successfully by combustion in an empty tube it does not necessarily follow that carbon and hydrogen can be. Indeed, Mixter[9] states that in his determinations on tobacco and coal respectively, a small amount of hydrocarbon gases and a small amount of tarry matter passed over unconsumed. In addition, ter Meulen and Heslinga[11] state that in their determination a slight deposit of soot which is difficult to avoid is no serious detriment provided all the sulphur is burnt to sulphur dioxide. It would appear, therefore, that it is possible to get complete sulphur recovery without perfect combustion, and therefore our investigations on the determination of carbon and hydrogen were undertaken.

The papers by Warren[4] and Marek[5] do deal with the determination of carbon and hydrogen, and we are glad to learn of them. It is of interest to examine the differences in technique compared with ours. Warren used a combustion tube packed with asbestos for a length of 10–12 in. and, moreover, recommended that a layer of copper oxide should be placed before the asbestos; so his method can scarcely be said to use an unpacked tube. Marek's work is of greater interest since he does appear to have achieved some remarkably accurate analyses using an unpacked tube. However, he admits that most of them were obtained using a platinum contact, which he somewhat naïvely says was not used because of its catalytic powers but to prevent possible explosions and also as an indicator of the course of the combustion. Thus neither of these workers recommend the use of an unpacked combustion tube.

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[3] Parr, S. W., "The Analysis of Fuel, Gas, Water and Lubricants" (McGraw-Hill Book Co., 1942), 27. Engelder, C. J., "A Laboratory Manual of Gas, Oil and Fuel Analysis" (Chapman and Hall, 1931), 168. Moore, E. S., "Coal" (Chapman and Hall, 1922), 48.
[4] Warren, C. N., *Z. anal. Chem.*, 3, 272 (1864).
[5] Marek, *J. prak. Chem.*, (2), 84, 713 (1911).
[6] Belcher, R., and Spooner, C. E., *Fuel*, 20, 130 (1941).
[7] Vita, A., *Stahl und Eisen*, 40, 933 (1920).
[8] Seuthe, A., *Arch. Eisenhüttenw.*, 11, 343 (1937–38). Glückauf, 19, 400 (1939).
[9] Mixter, W. G., *Amer. J. Sci.*, (3), 4, 90 (1872).
[10] Schöberl, A., *Angewandte Chem.*, 50, 334 (1937).
[11] ter Meulen, H., and Heslinga, J., "Neue Methoden der Organisch Chemischen Analyse" (Leipzig, 1927), 37.

Two New Carbonyls: Copper and Tellurium

WE are able to report the isolation of copper carbonyl, which we obtained from the reaction of carbon monoxide with heated cuprous oxide. It is a white, readily sublimable solid, the vapour of which is dissociated at a higher temperature with the consequent deposition of metallic copper. Only small quantities are formed, but enough has been collected to afford a preliminary analysis indicating $Cu(CO)_x$ as the empirical formula. A polymeric form would be expected in the case of copper, and its properties suggest that it is very possibly dimeric.

The copper mirrors obtained by Bertrand[1] and by Zelinski[2] by treating cupric oxide with carbon monoxide were thus probably correctly explained by them as due to a carbonyl. No record appears of any attempt by either author to separate the substance. Presumably the oxide contained some cuprous oxide, for we found that cupric oxide did not respond to carbon monoxide, and here we are in agreement with the findings of Mond and Heberlein[3]. From this and other work, Mond and Heberlein concluded that copper does not form a carbonyl. However, Boomer, Martin and Argue[4], using a catalyst made of equal parts of copper, aluminium and zinc in methanol synthesis, obtained an aqueous condensate which, after effervescence, precipitated a yellowish solid believed to be a hydrated copper oxide. In any event, copper was the only metal present. Special interest is attached to the observation because the more effective the catalyst the more the copper removed, as though an intermediate volatile copper compound, possibly a carbonyl, were the active agent. The volatile compound was not further characterized.

We have obtained tellurium carbonyl by the action of carbon monoxide on tellurium. The yields in this case, too, have been very small, but it has been shown to be a gas, and a comparison of its physical properties with those of selenium carbonyl, first isolated in these laboratories[5], and carbonyl sulphide make it clear that its formula is COTe. As expected, it has proved less stable than carbonyl selenide.

Details of these investigations will be published elsewhere.

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[1] Bertrand, *C.R.*, **177**, 997 (1923).
[2] Zelinski, *C.R.*, **177**, 1041 (1923).
[3] Mond and Heberlein, *J. Chem. Soc.*, **125**, 1222 (1924).
[4] Boomer, Martin and Argue, NATURE, **129**, 438 (1932).
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Ice-Crystal Haloes

A NOTE in NATURE of March 13, 1943, p. 300, reported the occurrence at Bournemouth of what was interpreted as the arc of contact to the 46° halo. Without complete data positive identification of the arc in question is not possible, but it is far more likely to have been the common circumzenithal arc.

The circumzenithal arc is formed by refraction through the 90° angles of ice prisms floating with their axes of symmetry vertical (Fig. 1). Because their orientation is fixed except for freedom to rotate about the axis of symmetry, this arc is well coloured; it may be faint, but the colours are always relatively pure, in sharp distinction from those of the other arcs and rings.

The true upper contact arc to the 46° halo depends for its formation upon a predominance of crystals floating with a 90° refracting edge horizontal (Fig. 2). As these prisms are otherwise randomly disposed the colours must be broken, and the arc will appear brownish-red.

FIG. 1.

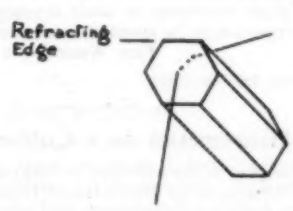

FIG. 2.

The conditions for the formation of the circumzenithal arc are readily fulfilled by the presence of umbrella-like crystals consisting of a flat plate on top of an elongate prism, or of prisms pyramidal at the lower end and hollow in the centre. It is difficult, however, to visualize the type of crystal that would give rise to the contact arc, which, if reliable records were available, might prove to be as rare as the parhelia to the 46° halo.

The mention of colour in the Bournemouth arc, the low sun at 4 p.m., February 8, the lack of mention of any 46° halo, and the commonness of the circumzenithal arc, make it reasonably certain that the latter was the arc in question. This arc may be expected any time that parhelia to the 22° halo occur with a solar altitude of less than 32°, provided that the cirrostratus sheet extends overhead.

My observations for the year ending October 15, 1943, may give some idea of the relative commonness of the better-known ice-crystal phenomena:

22° halo	190 days
Parhelia to 22° halo	38 days
Circumzenithal arc	13 days
Sun pillar	9 days
Circumscribed halo of 22° halo (including contact arcs, that is, incomplete halo)	8 days
46° halo	6 days
Horizontal or parhelic circle	5 days

It may be noted that the rainbow was seen on four days in this period and the fogbow (white rainbow) once. These and earlier records show that some of the ice-crystal phenomena are considerably commoner locally than is the rainbow. The fact that many people have never seen even the 22° halo is partly due to a disinclination to look close to the sun or high in the sky.

In three years of consistent observations I have seen Lowitz' arcs four times, and a 19° halo, the counter-sun and the parhelia to the 46° halo once each. The last two were part of a beautiful display already described[1]. I have yet, however, to see the contact arc to the 46° halo.

From 15° to 25° solar altitude the circumzenithal arc is virtually tangent to the large halo, but outside this range it quickly departs from it. The confusion of these arcs is widespread, and is even revealed in the records published by Pernter[2]. The distinction is emphasized by Minnaert[3], whose fascinating book is recommended to the interested reader.

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[1] Savile, *Mon. Weather Rev.*, **69**, 73 (1941).
[2] Pernter, J. M., "Meteorologische Optik" (3rd Edit., 1902).
[3] Minnaert, M., "Light and Colour in the Open Air" (London, 1940).

Grey Mould (*Botrytis cinerea*) of Flax

IN the course of the examination of large numbers of samples of flax seed by the Ulster method[1] for the presence of seed-borne parasites, many were found to be contaminated with *Botrytis cinerea*. As in some of the samples more than 25 per cent of contaminated seeds was recorded, the pathogenicity of the isolate from home-saved seed was investigated, since *B. cinerea* is known to cause grey mould of flax.

Seeds from a sample known to be free from any known parasite were dipped into a suspension of spores prepared from a pure culture of *B. cinerea* isolated from flax seed. The inoculated seeds were sown in pots of moist sterilized soil which were then covered with sterile bell jars. A few days after the appearance of the cotyledons a number of seedlings produced from inoculated seeds showed brownish-coloured lesions on the hypocotyl at about soil-level; these seedlings afterwards developed the typical symptoms of 'damping off'. Conidiophores first appeared on that portion of the hypocotyl which was originally attacked, and within a short time spores were produced on all aerial parts of the dead seedlings. No difficulty arose in making isolations of the causal organism from the hypocotyls of seedlings showing early symptoms of attack. Seedlings in control pots sown with uninoculated seeds remained healthy provided the covering bell jars were not removed. The experiment was repeated using spores from isolates from diseased seedlings, and similar results were obtained. The work was carried out in an unheated greenhouse during the summer.

Van Poeteren[2] investigated the control of grey mould by seed disinfection and obtained good results.

The efficacy of those seed treatments which were found to give a good measure of control of other seed-borne diseases of flax in Northern Ireland[3] was accordingly tested. The effectiveness of each treatment was determined in the laboratory by the modified Ulster method[4], five hundred seeds being examined in each case. Treatment with 'Nomersan' at the rate of 12 oz. per cwt. of seed or with 'Ceresan U564', using an 8 per cent solution at the rate of 0·9 gal. per cwt. of seed, reduced the contamination of the seed with viable *B. cinerea* from 15·0 per cent in the control to 0·4 and 1·4 per cent respectively in 1942 and from 13·1 per cent (control) to 1·2 and 1·6 per cent respectively in 1943. Organo mercurial powders applied by the 'fixation' method of seed treatment were not so effective.

In pot experiments made both in the greenhouse and under an open outdoor verandah very satisfactory control of the disease was obtained by the use of both 'Nomersan' and 'Ceresan U564'. In field tests 'Ceresan U564' was very effective, 'Nomersan' also giving good results. Unfortunately, in the field trials made in 1942 the development of the disease was almost completely checked at a very early stage by the onset of cold dry weather, and the yield of fibre was not influenced by treatment. In a similar field trial in 1943 the disease did not appear even in the control plots, probably due to the cold weather which followed sowing.

Observations made in the field show that *B. cinerea* can attack and kill portions of stems of mature plants, and that it is often present on the stems and capsules of plants if prolonged periods of damp weather occur after the crop has been pulled.

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[1] Muskett, A. E., and Malone, J. P., *Ann. Appl. Biol.*, **28**, 8 (1941).
[2] Van Poeteren, H., *Versl. en Meded. Plantenziektenkundigen Dienst te Wageningen*, **44**, 60 (1926).
[3] Muskett, A. E., and Colhoun, J., *Ann. Appl. Biol.*, **30**, 7 (1943).
[4] Muskett, A. E., and Colhoun, J., *Ann. Bot.*, N.S. **6**, 219 (1942).

Future of Anthropology

PROF. LE GROS CLARK[1] takes exception to remarks which I made in reporting a discussion on the future of anthropology at the recent centenary meeting of the Royal Anthropological Institute. The point at issue concerns the scope of physical anthropology. It would be generally agreed, no doubt, that this is a practical question concerning the convenience of study rather than an attempt to frame a logical definition of a subdivision of science.

Prof. Le Gros Clark refers to his presidential address to Section H of the British Association in 1939. In this he adopts the commonly held view that physical anthropology is concerned with the evolutionary history of man. This is a historical theme though it embraces the study of existing populations. Contact is made with the activities of students who are concerned with living peoples but who have no special interest in any historical theme. It is clear that research in this field cannot be divided into a number of separated compartments. It should all be related and interdependent, however various the approaches may be.

In the communication referred to, the physical anthropologist is urged to study "comparative racial physiology". His subject, we are told, should be *completely* re-orientated "along functional lines", its *main* concern (the italics are mine) being the study of physical efficiency in "native populations", with reference to all factors which influence it—such as inborn differences, nutrition and other environmental conditions—and all other relevant kinds of evidence, including medical and demographic statistics and the application of various physiological and other tests. But why restrict the scope of such inquiries to native populations, since anthropology is concerned with the whole of mankind? Are its students also expected to carry out research on the same lines for all "advanced" populations as well?

It is clear that research of the kind referred to is needed, and that its results would be of interest to physical anthropologists. The question is whether they can be expected to consider that problems of the kind referred to should be their special concern. If they do, then the diversion of their very limited resources—at present almost non-existent in Great Britain—must entail neglect of 'academic' physical anthropology. Alternatively, it may be supposed that researches into the social biology of any kind of society can be more properly considered the concern of other workers, whether they be called social biologists, or eugenists, or something else. They might well urge that investigation of the questions involved, which are of immediate practical importance, should be undertaken by the State and not left to university workers.

Prof. Le Gros Clark exclaims at the suggestion, which he incorrectly attributes to me, that physical anthropologists cease to be such if they deal with practical problems. I should say that in so far as they do so, they are serving the 'applied' rather than the 'pure' interests of their science. Zoologists are not expected to be specialists in animal husbandry.

THE WRITER OF THE ARTICLE.

[1] NATURE, **152**, 680 (1943).

Mathematics as a Cultural Subject

THE plea in the editorial in NATURE of November 13 on "Science as an Educational Discipline" will find a warm welcome from those who have been concerned with spreading an understanding of the broad significance of science for modern society as well as the details of particular parts of science. Paying less attention to sharp division of science into different subjects and more to the interrelation of these subjects, the history and development of our great heritage and the social possibilities which it holds forth will help to spread a better appreciation of what science stands for among the population at large.

Here I would like to urge that mathematics should also be treated from the same point of view, and should not be put on one side as though it were totally different. The conventional approach to the subject only too often seems to make it appear mysterious, esoteric and external to the pupil's experiences. Without a clear understanding of what mathematics can do and what it cannot do, then it is very easy to be misled by all kinds of arguments using quite unjustifiable mathematical proofs. If mathematics is linked up more closely with the physical sciences, then it is possible to explain the significance of such developments as the calculus and graphs, and to

show that they represented a real advance for mankind instead of merely examination examples; the exaggerated emphasis on plane deductive geometry will give place to a better understanding of the spirit of mathematics. Judging from the school syllabuses, one would imagine that every mathematician was continually using logarithm tables, whereas the present tendency is more and more to use machines both in commerce and in research laboratories.

It is not possible, however, to estimate correctly the importance of mathematics if it is only considered in relation to the physical sciences. Mathematics is very closely related to both the natural and the social sciences, although so far in history the main impetus for its development has come from the former; this is mainly because society hitherto has been much more interested in the natural sciences because of their immediate importance in technology. Nevertheless, statistics owes its development to the social sciences. Even at quite an elementary level, a proper treatment of averages brings in ideas which are not common to other parts of mathematics and which are important in the world to-day. During the War, increasing use has been made of the methods of pictorial statistics in order to make numerical results more understandable.

Lastly, it should never be considered that greater emphasis on these broader aspects of mathematics and science is only of value to the 'man in the street' and not to the expert. To-day we are meeting all kinds of interconnexions between apparently unconnected parts of science, and the person who specializes on one narrow section without appreciating its relation to the whole of modern knowledge is apt to take longer in his work and not see its true significance when completed.

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Area Heating

HAVING been responsible for many large district heating plants on the Continent, I have read with great interest the article "Area Heating" in NATURE of October 30. It is often said that in Great Britain, with its mild climate, there is no need for district heating. The ever-increasing number of central heating plants, however, shows the urgent demand for centralized, labour-saving heat supply; and by the adoption of district heating, relatively more coal can be saved in Britain than on the Continent. By co-ordination of heat and electric-power generation, it will be possible to reduce the present consumption of coal for heat and electric power generation in towns and cities more than by half, and to eliminate entirely the smoke nuisance with all its evil effects.

The co-ordination of heat and electric power generation is, however, a more complicated and difficult matter than it appears to be from Dr. Hughes's article. The thermal efficiency of electric power generation from steam greatly depends upon the vacuum, and the cooling water is heated in the condenser to a temperature of 85°–100° F. only, which is of no use for heating purposes. Higher temperatures can only be attained by an increase of the back-pressure, and this is accompanied by a corresponding increase in steam consumption for electric power generation. A further difficulty is that the hourly, daily and seasonal variations of the heat and electric power loads do not coincide. The daily variation can be overcome, as Dr. Hughes rightly pointed out, by hot-water storage, but this method is not applicable for seasonal variations.

According to Dr. Hughes, after the War new electric power stations will be required. Should it be the case, it would be better, from the point of view of district heating, to install the new generating capacity in existing stations as back pressure sets for heat and electric power generation. This will give a much greater flexibility for development of district heating than new large heat electric stations.

The suggestion of Dr. Hughes to burn the coal in new boiler stations located on the rim of large centres of population and to transmit the steam to turbo-generators located at the centre of gravity, disposing of the heat in the surrounding domestic and industrial areas, is probably due to a misapprehension. In my paper before the Institution of Heating and Ventilating Engineers[1], I showed the possibility of electric power generation in two, or even three, pressure stages when co-ordinated with district heating. In the primary station, steam of high pressure is used for electric power generation with back pressure sets, and the steam of, say, 200 lb. per sq. in. abs. is transmitted to the older station to feed the back pressure sets for electric power and heat supply. Thus the boiler house can be eliminated and generation of electric power and heat is made possible inside a town without the burning of coal. The steam from the primary station must, of course, be delivered to the secondary station with sufficient superheat. Therefore, the steam main must be carefully insulated to reduce the loss of the valuable superheat as much as possible. But even mains carrying low-pressure steam or hot water and accumulators have to be carried out with good insulation. Owing to the increased transmitting capacity, the percentage of heat losses of large mains is very small. The actual heat losses and their costs, however, are practically proportional to the area of the pipe surface. The economic thickness of the insulation has, of course, to be calculated for every scheme, but it has generally been found that good insulation pays.

The saving in fuel was the main argument for the introduction of district heating in the U.S.S.R. That country is now leading in the development of district heating, and the new electric power stations are already predominantly built for co-ordinated heat and electric power supply.

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[1] "Experience with District Heating in Europe and U.S.A. and its further Development". *J. Inst. Heat. and Vent. Eng.* (November 1935).

I AM particularly glad that Mr. Margolis has been prompted to publish more relevant information on area heating, and to correct some of my speculations based on the technical data already available. I certainly did not intend to convey the idea that area heating could be effected from existing plant. I agree that the location of boilers at a distance from the generating station is probably uneconomic, but if the advantages to a community are sufficiently recognized, maybe the community might sanction the excessive cost.

L. E. C. HUGHES.

RESEARCH ITEMS

Genes and Development

IN two papers, H. Grüneberg (*J. Genetics*, **45**, 1–22, 23–29; 1943) describes his recent work in analysing the manner in which genes causing abnormalities in the mouse exert their influence. A recessive gene *ch* results in the development of hydrocephalus, but the most interesting point is that the final effects of the gene are due to anomalies in the early development of cartilage. As a result of the aberration in cartilage development, there is a shortening of the basi-cranial cartilage and nasal septum. This gives rise to a dorsal bulging of the cranial hemispheres. The lower part of the brain is compressed and interferes with the normal drainage function of the foramen of Magendie; hence hydrostatic pressure is increased. The bulge thins out the osteogenic membrane and prevents the formation of the membrane bones. Strain on the blood sinuses leads to internal hæmorrhage, while skin strain gives rise to other anomalies. These various pleiotropic effects are thus shown to be secondary effects of the cartilage anomaly. Grüneberg claims that pleiotropism does not exist, but that a gene produces only one chemical reaction; and there is no reason to suppose that genes have more than one action. The gene, says Grüneberg, is cell- or tissue-specific and never organ-specific in action. He suggests five postulates for the analysis of gene action, which include biochemical and morphological methods. In the second paper Grüneberg describes two further mutants in the mouse—fidget and hydrocephalus—which present interesting features for similar developmental studies in the future.

Development in Drosophila

C. H. WADDINGTON (*J. Genetics*, **45**, 29–44) and C. H. Waddington and R. W. Pilkington (*J. Genetics*, **45**, 45–50; 1943) describe the effects of several leg and eye genes respectively in *Drosophila melanogaster*. The obvious effects of the leg genes dach, dachous, comb-gap and four-jointed are seen in the foreshortening of the legs, but they also affect other parts of the body. In combination, there is found additive effects and exaggeration phenomena in different organs in an apparently inconsistent series. Waddington considers that the explanation should be sought in the effect of the genes upon the folding of the imaginal buds. Where abnormal folding of the buds takes place by aberrant growth, the succeeding abnormal histogenesis will give rise to the various pleiotropic effects. Indeed, X-ray radiation of the imaginal buds during their growth gives similar abnormal folding and similar manifestations in the characters. Waddington and Pilkington have traced the development of eyes of Drosophila carrying the genes facet, lozenge-spectacled, ophthalmopædia and morula. Several remarkable divergences from normal development are described. The authors consider that, as in the work described in Waddington's paper, the genes disturb the method of folding of the imaginal buds.

Wheat-Puccinia Relationships

ALTHOUGH the haustoria in *Puccinia graminis Tritici* penetrate the cells, they remain external to the protoplasts, and the latter can be plasmolysed independently of the haustoria, which themselves are plasmolysed by solutions with concentrations 3–4 atmospheres higher. This aspect focuses renewed attention on the permeability of the host cells, as in a recent paper (Thatcher, F. S., *Canad. J. Res.*, C 21, 151; 1943). Haustorial invasion always seems to be accompanied by an increase in the permeability of the host cell, often to the extent of being fatal. Treatment of plants with chloroform vapour, which increases the permeability of the protoplasts, leads to a lowering of resistance. Cold hardening, which also increases the permeability of the host cells, in some cases lowers the resistance, but this effect is probably offset by the increase in osmotic pressure induced at the same time. When the wheat variety Kubanka is grown at 80–85° F., the increase in permeability of the host protoplasts caused by the higher temperature seems to be the cause of the rapid early growth of the fungus—later the host protoplasts appear to have an adverse effect on the parasite since just before they die they cause the formation of brown walls round the haustoria and a kind of encystment. This results in the 'browning reaction' characteristic of Kubanka when grown at high temperatures. Certain varieties, which appear to occupy a threshold position between resistance and susceptibility, give an 'x' or 'mesothetic' reaction with certain races of *Puccinia graminis Tritici*. Infection rapidly leads either to pustules or resistant brown flecks, often both on the same leaf. Host cells from pustule and fleck areas showed higher and lower permeabilities respectively than did those from normal healthy areas. The mature resistance of Hope wheat may be due to its possession of a low water availability to the parasite—seedling leaves have a higher permeability and are less resistant than mature parts. The susceptibility of the host to rust is not modified by previous infection with smut, neither in oats, barley and maize nor in wheat.

Mineral Deficiencies in Fruit Trees

Two recent papers add to our knowledge about mineral deficiencies of fruit trees (*J. Pom. and Hort. Sci.*, **20**, Nos. 3 and 4; 1943). J. B. Duggan (pp. 69–78) has succeeded in restoring the green colour to the leaves of cherry trees which were chlorotic through manganese deficiency. This was accomplished by injecting solid manganese sulphate into large branches and into the trunk. Neither injection nor spraying with solutions of the salt was satisfactory in practice. The deficiency of manganese was established by spectrographic analysis of the leaves. D. W. Goodall investigated the intake of calcium, iron, magnesium, manganese and potassium into the apical, middle and basal leaves of various kinds of shoot and spur of the apple Cox's Orange Pippin. He found that intake of the various ions varied with manurial treatment. Samples from plots receiving sulphate of ammonia, for example, contained 42 per cent more manganese than from the plots without added nitrogen. Differences in the manganese and potassium status of different trees are reflected more clearly in the composition of the basal leaves of the fruiting spur than in that of other leaf types.

New Methods in Plant Breeding

DELPHINIUM species and varieties are diploid, tetraploid or hexaploid. Intercrossing between these groups will naturally lead to sterility if the hybrid is obtained. *D. cardinale* is a diploid species with a distinctive scarlet colour. G. H. L. Mehlquist, C. O. Blodgett and L. Bruscia (*J. Hered.*, **34**, 187; 1943) have used several methods of applying colchicine to

this species and have obtained tetraploid derivatives. These have been used in crosses with commercial tetraploid varieties of *D. elatum*, to introduce the scarlet colour and the high resistance to Erysiphe (powdery mildew) of *D. cardinale* into existing varieties. So far a few hybrids have been obtained, but many more can be expected.

Forms of Phosphoric Oxide

It has long been known that phosphoric oxide (P_2O_5) exists in different crystalline and glassy forms. W. L. Hill, G. T. Faust and S. B. Hendricks (*J. Amer. Chem. Soc.*, **65**, 794; 1943) have made a study of the preparation and identification of the different modifications, measurements of their optical constants, the phase transformations by the quenching method, and an interpretation of vapour pressure data. They conclude that there are three crystalline forms: hexagonal, rhombic and a stable (probably tetragonal) form, as well as a glassy form. The system involves three triple points at which solid, liquid and vapour (P_4O_{10}) co-exist in equilibrium, and there are at least two distinct liquid forms, one a stable polymer of the other, which were identified with the melting of the stable and hexagonal forms, respectively. Some X-ray data are given for the three solid forms. The stable form can be superheated above its melting point.

Bonded Deposits on Economizer Heating Surfaces

In a paper on this subject read recently in London by J. R. Rylands and J. R. Jenkinson before a joint meeting of the Institution of Mechanical Engineers and the Institution of Electrical Engineers, it was pointed out that the problem of boiler plant availability in power stations has become so prominent that a better understanding of the causes of the fouling of heating surfaces by deposits from the products of combustion is essential. Earlier theories based on fused ash particles, sodium sulphate bond or high dew-points have not satisfactorily accounted for various well-established facts of observation. The latter include the existence of a period of apparent immunity from deposits in a new boiler plant, the characteristic behaviour of the dust from pulverized fuel firing and the peculiar scale-like form of certain hard deposits occurring on economizer and boiler tubes. The authors have found that hard bonded deposits on economizers result from certain chemical reactions between fuel dust and sulphuric acid. The type of reaction depends on the temperature of the metal parts associated with the deposits. Practical suggestions for the prevention of hard bonded scale formation in economizers are made, various types of coal ash being discussed, and characteristics favouring bonded deposit formation pointed out. The influence of the authors' proposals on plant design is considered.

Solar Prominences

An important paper by E. Pettit (*Astrophys. J.*, **98**, 6; 1943) deals with the classification of solar prominences according to their association with sunspots, their origin, their motion and their structure. A tentative evolutionary sequence includes prominences of the quiescent, active, eruptive, sunspot and tornado types, and a new type, the coronal prominence, is distinguished. A comparative description of each type is given, and subdivisions of many of the classes are illustrated by diagrams and photographs. The paper forms a valuable summary of the results obtained by the assiduous study of the solar surface at the Yerkes and Mt. Wilson Observatories during the past two decades.

Multi-Colour Photometry of Stars

A new photo-electric photometer for stellar work has been recently brought into use at the Mount Wilson Observatory, and is now described by J. Stebbins and A. E. Whitford (*Astrophys. J.*, **98**, 20; 1943). With the 60-in. reflector, measurements can be made in a spectral range as wide as 3530–10300 A. on stars as faint as the ninth magnitude. The photocell used is of the cæsium oxide type and is especially sensitive to red radiation. A series of filters enables measurements to be made at six points from the ultra-violet to the infra-red. The instrument was designed to measure the colours of faint extended sources such as the nebulæ, but some results on stars incidental to the main programme are now published because of their intrinsic interest. These concern the colours of 69 stars of types *O* and *B* showing various degrees of reddening by interstellar absorption. Small deviations are found from the λ^{-1} law of reddening, in the sense that the radiation is fainter in regions intermediate between the ultra-violet and infra-red, but the law is the same for all directions in the galaxy. Even the simple λ^{-1} law requires *ad hoc* assumptions regarding the size distribution among the absorbing particles, and the deviation found will give further material for study. That the form of the reddening is constant simplifies matters somewhat; evidently equilibrium has been reached and the interstellar cloud must be regarded as a permanent feature of the galaxy.

Determination of Time Corrections

The Astronomical Institute of Sciences of the U.S.S.R. has issued "Ephemerides for the Determination of Time Corrections by Equal Altitudes (Zinger's Method) for 1941". Four quantities for each pair of stars are tabulated, these quantities depending only upon the co-ordinates of stars entering the given pair. The values of the four quantities refer to the moment of upper culmination of a fictitious star over the Greenwich meridian. The right ascension of this star is the mean of the right ascension of the two stars, and the moment of upper culmination is called the moment of culmination of the pair. Tables are given which provide these four quantities in a continuous reckoning through every ten culminations, that is, through ten sidereal days. In the heading of each pair of stars selected are numbers which denote the various working ephemerides, and the names of stars corresponding to the numbers are given in Table IV. Full explanations of the use of the ephemerides are given with examples, and the necessary calculations are very easily effected. In addition, it is shown how the calculations of chronometer corrections are carried out, and these are facilitated by a special table compiled for the purpose. Special attention is directed to the fact that, in computing the long-period terms of nutation, certain terms are omitted which have been newly introduced by some ephemerides, such as the "Nautical Almanac" and the "Berliner Jahrbuch". It is shown that the total effect of these terms on the half-sum of the right ascensions is negligible. The effect of the short-period terms of nutation are easily computed by means of special tables given for the pairs of the ephemerides by Prof. Zwetkoff.

FEEDING WASTE APPLES TO POULTRY

By H. TEMPERTON

National Institute of Poultry Husbandry, Newport, Shropshire

THE domestic poultry-keeper in return for the cancellation of each shell egg registration is entitled to purchase sufficient 'balancer meal' to furnish approximately half the total dry matter requirements to support one laying bird. This specially compounded meal is richer in protein and minerals than would be the case of a ration designed as the sole food for layers, and its composition has been so formulated that when supplemented by appropriate quantities of edible waste, mainly of a carbohydrate nature, from the kitchen and garden, it provides a suitably balanced ration for egg production. During the past three years a considerable amount of experimental evidence has accumulated on the use in poultry rations of surplus or waste products of the garden or allotment.

At this Institute we have received from time to time inquiries from poultry-keepers concerning the nutritive value of windfall and damaged fruits from dessert and culinary varieties of apple and from ornamental crab trees. Correspondence which has appeared in the poultry Press recently lends confirmation to the belief that there are many domestic poultry-keepers with access to supplies of these types of fruit who are uncertain of the advisability of feeding them to their stock. It has been claimed by some that the organic acids present in apples and pears, and particularly malic acid, exercise a pronounced laxative effect which may result in enteritis when appreciable quantities of fruit are consumed by the birds. Bayon[1] discredits this view on the grounds that the organic acids present in the fruit are less concentrated than the free acid of gastric juice. There are no references in the available literature to experimental observations on poultry, but Klimmer[2] makes the general statement that malic, tartaric and citric acids, which occur in the juices of many so-called acid fruits, all aid the digestive processes, promoting the digestion of albumen, and, in the presence of sugar, influencing the solubility and absorption of certain phosphates and other mineral salts which are insoluble in their absence.

The feeding trial which is now described was designed to provide a more factual basis on which to give advice.

The supply of apples used was of two types: (1) a heterogeneous sample of windfalls from culinary and dessert varieties collected from the ground in September and comprising badly bruised and scabbed fruit; (2) fruits picked at the same time from trees of the Siberian crab (*P. malus* var. *sibirica*).

A sample of the crab apples showed on chemical analysis the following percentage composition:

		Dry matter	
Moisture ..	83·0	Crude protein	5·00
Dry matter ..	17·0	Ether extract	0·97
		Crude fibre	4·60
		Nitrogen-free extractives	85·63
		Ash	3·80

Owing to the difficulties of obtaining a representative sample no analytical data were determined on the cultivated apples. For the purpose of this qualitative test five parts by weight of either source of apples were considered to provide the equivalent dry matter of one part of meal.

A group comprising ten first-cross pullets were used for the experiment and were housed in individual laying cages in a battery house and fed the following rations (oz. per bird daily):

	First 14 days	Remainder of test
Layers mash	4·0	3·0
Apples	5·0	10·0

The available supply of crab apples only provided for seven days feeding at the higher level and these were used during the fifth week of the test. During the first fortnight apples constituted 55·5 per cent of the gross weight of food eaten. The apples were minced by passing them through a vegetable shredder, and the juice which was expressed was conserved and used to mix the residual pomace and mash into a wet feed. The day's supply of food was provided in one meal given in the morning. No difficulty was experienced in getting the birds to consume the daily quota of food; on the contrary the ration appeared to be markedly palatable. The physical condition of the droppings remained normal and there was no evidence of scouring. After the test had been in progress for fourteen days the daily amount of mash allowed per bird was reduced by one ounce and replaced by a further five ounces of apples, which now constituted 76·9 per cent of the total weight of food offered. The appetite and general health of the birds were unaffected by this increase or by the subsequent inclusion of crab apples in the ration.

The experiment came to an end after forty-eight days, when the available supply of fruit was exhausted.

Experience at the Institute with laying pullets kept in individual cages in a laying-battery and fed an *ad libitum* supply of the particular meal used in the present instance has shown that the average daily consumption has been about 5 oz. per bird. On this basis the use of apples as part of the diet effected over the entire feeding period of forty-eight days a saving of 34·1 per cent of mash, or just over 5 lb. per bird, and constituted 72·1 per cent of the gross daily weight of food consumed. At the conclusion of the tests the average body weight of the birds showed an increase of 9·1 oz. No deaths occurred, and the health of the birds as judged by external characteristics was unimpaired by the rations fed. The short duration and limited scale of the test afford little more than indications of the effects on egg production. Average egg production is not a reliable reflexion, since two birds did not reach sexual maturity until after the test was concluded and others only came into lay towards the end.

The egg yield of individual birds which were in lay when the experiment commenced remained satisfactory and equal to that of similar birds receiving unrestricted access to a balanced laying mash.

The results of the test demonstrate that no toxic effects to laying birds are likely to follow the feeding of substantial quantities of ripe apples of the types used in the present instance. I am, however, not inclined to discredit the claim that under certain conditions the ingestion of apples can lead to pronounced digestive disturbances and impair the health of fowls, since observations have shown that where poultry, and more particularly young stock, have had access to unripe windfall apples these have been

readily eaten and followed by severe scouring. The experiences of youth provide an eloquent testimony of the diverse digestive effects following the abnormal intake of sour and ripe apples.

The disappearance of acidity due to the utilization of organic acids in respiration and in the synthesis of sugars is one of the concomitants of fruit ripening, but it is unlikely that this provides a valid explanation of the physiological disorders caused through eating unripe fruit, since medical experience indicates that the acidity of the digestive tract is entirely dependent on factors influencing the amount of the gastric secretion and its hydrogen-ion concentration.

Archbold[3] has demonstrated that the first stage in the growth-phase of apples following petal-fall is characterized by the formation of cell-wall material, and the intake of nitrogen. It is possible that the toxicity of immature fruit is due to a relatively high content of non-protein nitrogenous compounds, which are regarded as the principles responsible for similar physiological disturbances in larger farm livestock when unripe mangels or large quantities of young grass are suddenly introduced into the diet.

[1] Bayon, H. P., *Poultry Farmer* (August 20, 1943).
[2] Klimmer, M., "Scientific Feeding of the Domestic Animals" (Baillière, Tindall and Cox, 1933).
[3] Archbold, *Ann. Bot.*, **46**, 418 (1932).

CLEANSING OF MILK BOTTLES

MOST of us have received the familiar wide-mouthed milk bottle with its pressed-in cardboard stopper and, wiping with some anxiety its dirty neck, have wondered whether the milk is fit to drink. Remembering the difficulties of war and aware of the psychologist and his dirt-complex, we have reflected that anyhow the milk in our bottle is all the milk we can get and have tried not to be too fussy about it. The 'authorities', we know, have our cows tested for tuberculosis and do what they can to see that the milk we get is as clean as possible before it goes into the bottles; the medical men—and some others—wrangle interminably about the obvious advantages of pasteurization; but may not all these efforts be stultified by inefficient methods of washing, filling and distributing milk bottles? May not a roundsman who is naturally unaware that he is a typhoid carrier undo all the labours of those who have provided him with typhoid-free milk?

The first answer to these natural anxieties of the milk consumer is the Milk and Dairies Order, 1926—note the date—which requires that all milk containers and all appliances which come into contact with milk shall be thoroughly washed as soon as may be after use and shall be cleansed and scalded with boiling water or steam before they are used again; the second answer is that the Ministry of Health, three years before the War, asked for a survey of bottle-washing plants to find out whether treatment of them with caustic detergents was as good bacteriologically as steam sterilization. The results of this inquiry, carried out between October 1937 and July 1939, by G. S. Wilson and Betty C. Hobbs, were given in a full report to the Ministry, a copy of which can be seen at the library of the London School of Hygiene and Tropical Medicine. An abridged version appears in the *Journal of Hygiene* (**43**, 96–120; 1943).

Its conclusions can be given only briefly here; on the whole, they will reassure the householder. They agree largely with the results of similar investigations in the United States. A total of 2,406 milk bottles from 105 washing and distributing plants of 26 different types was examined. Hand washing of bottles is condemned. Small dairies often disregard the Milk and Dairies Order. Steam sterilization is efficient if it is carefully done; otherwise it is not. But on the whole, equally good results were obtained in large and small rotary plants with either steam sterilization or hot caustic detergent (caustic soda with or without additions). The spray type of washing machine was the best, and the best results were obtained without brushes. Virtual sterility could be obtained with either strong caustic soda at a low temperature or with weak caustic soda at a high temperature, and it is not necessary to change the detergent more often than occasionally, provided that it is brought daily up to strength and that foreign matter is filtered out and deposit in the tanks is removed every few days.

One very interesting result was that no coliform bacilli were found in the washed bottles. The detergent killed these. This would eliminate, in well-conducted plants, milk-borne diseases derived from homes from which empty bottles are returned; but can we be sure that all plants are conducted well enough to ensure this? Of the organisms found in the washed bottles about half were saprophytic, one quarter were cocci and one quarter were yeasts, moulds, hæmophilic organisms and aerobic spore bearers. These, like the coliform bacilli, would have been killed by the detergent, so that they must have got into the bottles after they had left the detergent. It was found that most of them came from the rinsing water used to get rid of the detergent, which was heavily contaminated.

United States workers have recommended the use of chlorinated water to remove the detergent and to check the bacteria in the rinsing water, but Hobbs and Wilson prefer a rinse in water at 120° F., followed by cooling by washing the exterior only of the bottles at decreasing temperatures, until a temperature of 70° F. is reached. A final cold spray from the water main over both the outside and inside of the bottle completes their process. If bottles are hotter than 68° F. when milk is put into them, the life of the milk will suffer. Frequent cleaning of the washing machines is, of course, desirable.

To these complex problems of washing and cooling on a large scale must be added the important one of storage of bottles in small plants, where they are kept some hours or even overnight before they can be filled. Bottles should never be stored the right way up. When they are inverted their bacterial content depends on the amount of moisture and the temperature; in warm damp weather it is likely to be higher.

Householders will be glad to learn that the familiar wide-mouthed bottle with its cardboard stopper is condemned; it would be more satisfactory if a hooded cap covered its neck. A narrow-necked bottle with a press-over cap, or a bottle with recessed angles, would lessen the risk of contamination of the milk when it is poured over a dirty and frequently handled brim. A paper-board container which is used only once is the ideal, but it is too expensive at present.

The importance of clean milk bottles is shown by reference to the literature on typhoid epidemics and other milk-borne diseases. In the United States, 296 out of 373 outbreaks of typhoid were traced to carriers either on the farms or in the milk-distributing plants.

While we need not, in Great Britain, be unduly alarmed by such figures as these, the fact remains that clean milk is a vital concern of the whole community. If the farmer and the veterinary surgeon do their best to give us clean cows and clean milking, we should see to it that the bottling and distributing organizations do not introduce disease. The householder has an important responsibility too—he should see that used bottles are well washed in hot water before they are returned to the roundsman, especially if there is communicable disease in the house. The problem is complex, requiring, like so many features of our modern civilization, the willing co-operation of all who take part in the chain of operations which link the producer with the consumer. The authors of this paper are to be congratulated on the completion of a very complex and difficult piece of public work. Before they could do it they had to work out methods which are valuable contributions to knowledge.

G. LAPAGE.

PALÆONTOLOGY WITHOUT FOSSILS IN THE 'BIRD-WING' BUTTERFLIES

EVER since the days of the immortal Wallace, biologists have been intrigued with the distributional problems presented by the fauna of the Malay Archipelago. Probably the butterflies have proved more attractive than any other group, not only on account of their æsthetic charm, but also because the pattern and colour of their wings are susceptible to modification by isolation and climate. There is no doubt that Wallace had the butterflies in mind when he wrote in 1869: "It is certainly a wonderful and unexpected fact, that an accurate knowledge of the distribution of birds and insects should enable us to map out lands and continents which disappeared beneath the ocean long before the earliest traditions of the human race".

The latest contribution to this subject is of considerable interest and is described by the author, Dr. F. E. Zeuner, as "palæontology without fossils".* Essentially, it comprises an attempt to reconstruct phylogenetic trees for the 'bird-wing' butterflies on the basis of the morphology of the species-groups and the present distribution, and the evolutionary patterns thus obtained are compared with the geological history of the Malay Archipelago. The more or less complete agreement found between these two methods of approach is highly satisfactory.

In order to obtain the requisite data for an accurate division of the 'bird-wing' butterflies into species-groups, a considerable amplification of previous systematic work on this genus has been necessary, and this has been carried out principally on the basis of the male genitalia. Accordingly, the 'bird-wing' butterflies are divided into two major groups, the *Troides* Hübner + *Trogonoptera* Rippon group and the *Ornithoptera* Boisduval + *Schoenbergia* Pagenstecher group.

The phylogenetic trees for these two major groups are reconstructed on the reasonable assumption that each of the groups of subspecies existing at the present time has been derived from a common ancestral form in comparatively recent times and that, at some earlier period, each of the species-groups present to-day was a subspecies-group, and so on until a stage is reached when there was a common ancestor for each of the two major groups. All the known species of the Troides + Trogonoptera group can be obtained from a single parent-form on the assumption that this division into subspecies which eventually became differentiated into species has taken place at least five times. There can be little doubt that the common ancestor of the essentially western Troides complex originated in Sundaland, that is, in the continental land-mass formed by the union of the Malay Peninsula, Sumatra, Java and Borneo in the Tertiary. The Ornithoptera + Schoenbergia group can also be reduced to a single form on the assumption of five successive phylogenetic waves. While it is clear that the Ornithoptera complex of species has developed in the Papuan area, its past history is by no means so manifest as that of the Troides group for, in its earlier stages, the distribution of Ornithoptera proper was discontinuous, representatives being confined to the Moluccas and the Solomon Islands, while there was an interclave of Schoenbergia in New Guinea.

Regarding the geological history of the Malay Archipelago, it is evident that the continual fluctuation in the sea-levels between the Malay Peninsula and the islands of Sumatra, Java and Borneo, which resulted in these lands being united and separated repeatedly during the Pleistocene, was a factor of outstanding importance as regards species formation in the Archipelago, and accounts for the very large number of groups of closely allied species existing in Malaysia to-day. Of less importance were the changes in sea-level between the Aru Islands, New Guinea and Australia on the Sahul Shelf during this period, although the effects were similar. The remaining large island groups were isolated throughout the periods under discussion.

The formation of a large number of the geographical races (subspecies) found in Malaysia and in the region of the Sahul Shelf to-day dates from the final elevation of the sea-level after the last low level of the Last Glaciation, whereby the then existing land-masses were separated finally into their constituent islands. While the present subspecies and species of the 'bird-wing' butterflies are approximately of Holocene and late Pleistocene origin respectively, the phylogenetic stages previous to these two belong to the late Tertiary. The author computes that the evolution of the Troides group as a whole has occupied a period of between three and twelve million years.

Two outstanding problems concerned with the distribution of the 'bird-wing' butterflies are the overlap of the two major groups in the Moluccas, and the curious discontinuous distribution of ancestral Ornithoptera, which occurred in the Moluccas and Solomons and was absent from New Guinea. It may be mentioned that one or two of the present-day species of *Euploea* Fabricius (Danaidæ) show a similar hiatus in distribution so far as New Guinea is concerned. Dr. Zeuner considers that both these anomalies are explicable on the theory of continental drift. If New Guinea has advanced to its present position from a more southerly one during the Tertiary and Pleistocene and pushed the Moluccas and Solomons apart, and the Moluccas have been moved round from a position whereby the northern Moluccas occupied a more easterly site than at present, then these distributional problems are resolved.

A. STEVEN CORBET.

* Studies in the Systematics of *Troides* Hübner (Lepidoptera Papilionidae) and its Allies: Distribution and Phylogeny in Relation to the Geological History of the Australasian Archipelago. By Dr. F. E. Zeuner. *Trans. Zool. Soc. Lond.*, **25**, 107-184 (1943).

STUDIES OF POPULATION CHANGES

AMONG the papers read before the American Philosophical Society at its mid-winter meeting, February 19–20, 1943 (*Proc. Amer. Phil. Soc.*, **87**, No. 2, August 16, 1943) is one by F. W. Notestein of the Office of Population Research, Princeton University, on "Some Implications of Population Change for Post-War Europe". Mr. Notestein points out that we have been living in a unique period of the world's demographic history—a period of unparalleled population growth, which in Western Europe is drawing to a close. After discussing the fundamentals of population change, he applies general principles based on the vital trends of the inter-war period to derive age schedules of fertility and mortality for the future, from which he and his colleagues have constructed a series of population projections for the years 1940–70 for the U.S.S.R. and each European nation as of the 1937 boundaries. The fundamental assumptions are: (1) that the future course of mortality and fertility will represent an orderly development of the trends of the post-war period; (2) that there will be no international migration; and (3) that there is no war.

These projections indicate that the north-western and central region will reach its maximum population by 1950; in England and Wales, Sweden, Estonia, France, Belgium and Switzerland the maximum will be attained or passed by 1945; in 1955 by Scotland, Latvia, Finland, Norway, Germany, Austria and Czechoslovakia. While the effect of the War cannot at present be estimated, assuming the losses in the present conflict are proportional in each age-group to those of the War of 1914–18, it can be computed that the German population of 1950 will be about 25 millions less because of the decline in fertility and 10 millions less because of the losses of two wars. Accordingly, Mr. Notestein suggests that throughout this region society must be reoriented towards the interests of children, probably detracting somewhat from the current preoccupation with the needs of the aged. It may also have to be less oriented towards strictly individualistic values and more toward those of the group.

In southern and eastern Europe the principal characteristic of the period 1940–70 is a rapid increase in the persons of working age, and accordingly throughout the period there will be constant danger of pressure of population on developed resources in a region already suffering from pressure of population on its predominantly agricultural economy. Such pressures must be relieved in this region of deep hatreds if strife is to be avoided. Prompt relief, it is claimed, can only come from two sources: absorption of the region by the Soviet Union, which has ample resources and an enviable record in dealing with ethnic heterogeneity, or an economic and political solution by the Western Powers. The latter would be impossible if a series of small sovereign States were set up. The solution lies in the creation of a wide trade area of relatively free migration into which outside capital and skills are brought to foster industrialization and urbanization.

In contrast with the other regions, the Soviet Union faces rapid growth in all sections of its population more than five years of age, and this growth in population will probably be matched with a growth in power. The Soviet Union has ample natural resources to support its prospective population within its present boundaries, and Mr. Notestein concludes that it is difficult to escape the view that the Soviet Union in the coming decades will be the strongest single Power in the world. The United States, in his view, could not wisely stand apart from an association for collective security based on the mutual self-interest of the community of nations.

Included in this symposium of papers on post-war problems is a paper by the late Prof. Franz Boas of Columbia University, which was read before the Society on November 21, 1942. In this paper, "Individual, Family, Population and Race", are briefly summarized the results of an investigation of a number of highly mixed populations, like those of the eastern large cities of the United States, of other groups more uniform because members of a well-defined national group, and by contrast isolated groups that had for long intermarried among themselves, such as the Scandinavians of the Faroe Islands, the East Siberian tribes of the Chukchee Peninsula, Chippeway Indians of a few communities that have for long intermarried, the Bastards of South Africa, the Pitcairn islanders and a mixed Malay Dutch population from Kissar.

The results of the study demonstrate a sharp cleavage between the isolated groups and the two other groups, and Boas infers that there is no human group in existence which is so uniform either in fraternal groups or in family lines that any one individual can be considered as a representative of the group. In other words, there are no characteristics known that would allow us to claim that individual characteristics are determined by traits common to the whole group. The component individuals of any group vary markedly among themselves, and 'race' does not determine human behaviour. While Boas does not claim that it has been proved that biologically or genetically determined characteristics are exactly the same in all populations, he maintains that every known population, no matter on what princip'es it is selected, shows a wide degree of variation of forms; that no pure human race exists, and that behaviour is much more rigidly controlled by natural and social environment than by descent.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, January 1

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Vibrations and Waves", 3: "Sound Waves".*

Monday, January 3

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 2.30 p.m.—Mrs. Reginald Wyndham: "In the Netherlands Indies", with Kodachrome and other Films (Christmas Lecture for Young People).

SOCIETY OF CHEMICAL INDUSTRY (LONDON SECTION AND FOOD GROUP) (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 2.30 p.m.—Prof C. R. Harington, F.R.S.: "The Contribution of Chemistry to Immunology" (Jubilee Memorial Lecture).

Tuesday, January 4

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Vibrations and Waves", 4: "Visible Light".*

Tuesday, January 4—Wednesday, January 5

AGRICULTURAL EDUCATION ASSOCIATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1).—Half-yearly Conference.

Tuesday, January 4

At 9.30 a.m. (Agriculture Section).—Dr. John Hammond: "The Breeding of Cattle for Milk or Meat"; Reports by Dr. S. Bartlett and Dr. J. Edwards on "The Reading and Cambridge Artificial Insemination Centres".

At 11 a.m. (Dairying Section).—Mr. F. K. Neave: "The Sterilizing of Dairy Utensils by Hypochlorites".

At 11.15 a.m. (Chemistry Section).—Mr. W. Morley Davies: "Plant Nutrition".

At 2.30 p.m. (Paper Reading Session).—Discussion on "The Agricultural Education of the Youth of 15 years of Age and Over" (to be opened by Mr. A. S. McWilliam, Mr. C. R. E. Gillett and Mr. J. Hunter Smith).

Wednesday, January 5

At 9.30 a.m. (Paper Reading Session).—Mr. D. J. McLaren: "Some Suggestions for Organizing Instruction in the Care, Maintenance and Use of Implements and Machinery within the County Agricultural Education Framework"; Mr. C. Davies: "Specialised Farm Machinery—What is Necessary and What is Customary".

Thursday, January 6

BRITISH ECOLOGICAL SOCIETY (in the Department of Botany, The University, Oxford), at 10 a.m.—Annual General Meeting.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Vibrations and Waves", 5: "Short Electromagnetic Waves".*

Friday, January 7

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 2.30 p.m.—Miss Francesca French: "China—the Western End of the Great Wall" (Christmas Lecture for Young People).

INSTITUTE OF PHYSICS (LONDON BRANCH) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. R. Stoneley, F.R.S.: "Earthquakes".

Saturday, January 8

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. C. E. N. Bromehead: "Geology and Health".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Vibrations and Waves", 6: "Long Electromagnetic Waves".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEADMASTER of the Ashington Mining School—The Director of Education, County Hall, Newcastle-upon-Tyne (January 7).

ASSISTANT (temporary) IN AGRICULTURE at the Somerset Farm Institute, Cannington, near Bridgwater—The Clerk to the Somerset County Council, County Hall, Taunton (January 10).

TIME AND MOTION STUDY ENGINEERS (Order No. Q.56628), and TIME AND MOTION STUDY ASSISTANTS (Order No. Q.56638), for Government Posts in the Provinces—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting appropriate Order No.) (January 12).

TEACHER OF ENGINEERING SCIENCE, MATHEMATICS AND DRAWING in the Junior Technical School—Mr. E. B. Stockdale, Education Office, Mexborough, Yorkshire (January 14).

WOMAN PSYCHOLOGIST (whole time) at Twickenham Child Guidance Clinic—Mr. C. W. Ratcliffe, "R2", Clerk of the Middlesex County Council, Middlesex Guildhall, Westminster, London, S.W.1 (January 14).

TEACHER IN ENGINEERING SUBJECTS (possessing Graduate or equivalent qualifications in Mechanical Engineering and Industrial experience) at the Melton Mowbray and District County Technical College—The Director of Education, County Education Office, Grey Friars, Leicester (January 6).

GRADUATE (temporary) for MECHANICAL OR CIVIL ENGINEERING SUBJECTS, together with MATHEMATICS, at the Denbighshire Technical College, Wrexham—The Director of Education, Education Offices, Ruthin, Denbighshire (January 8).

Acting full-time DEMONSTRATOR OF ANATOMY—The Dean, Medical College, St. Bartholomew's Hospital, London, E.C.1 (January 11).

ENTOMOLOGIST in the Department of Agriculture, Salisbury, Southern Rhodesia—The Official Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (January 31).

LECTURER OR PHYSICS—The School Secretary, St. Mary's Hospital Medical School, London, W.2 (February 1).

CHIEF ENGINEER for large Chemical Works near London, to take charge of Installation, Maintenance and Mechanical Running of Plant, together with the Upkeep of all Services—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.1869 XA).

LECTURER IN ENGINEERING in West Africa—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E. 836A).

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